Static Strength Properties of Artificially Cemented Sands

by

Aiban Saad Ali

A Thesis Presented to the

FACULTY OF THE COLLEGE OF GRADUATE STUDIES

KING FAHD UNIVERSITY OF PETROLEUM & MINERALS

DHAHRAN, SAUDI ARABIA

In Partial Fulfillment of the
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In

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بسم الله الرحمن الرحيم

قال الله تعالى :

مِنْهَا خَلَقْنَاكُمْ وَفِيهَا نُعِيدُكُمْ وَمِنْهَا نُخْرِجُكُمْ تَارَةً أُخْرَى

صَدَقَ اللهُ العَظِيمُ

سورة طه آية رقم (٥٥)

In the name of God, Most Gracious, Most Merciful.

From the (earth) did We Create you, and into it Shall We return you, And from it shall We Bring you out once again.

(A. Yusuf Ali. "The Holy Quran:Text, Translation and Commentary", Hafner Publishing Company, N.Y.,USA, Volume One, p.800, 1978)

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

NOTATIONS

a	=	Intercept of the p-q diagram with the vertical axis
AO	=	Initial cross-sectional area of the cylindrical test specimen
B	=	Skempton's pore pressure parameter
BR	=	Burette reading for volume measure of test specimen
c	=	Cohesion intercept
CS	=	Conventional strain
DDR	=	Deformation dial reading
DS	=	Deviator stress ($\sigma_1 - \sigma_3$)
LO	=	Initial length of the specimen
LDR	=	Load dial reading
N	=	No. of blows per layer
p	=	$\frac{\sigma_1 + \sigma_3}{2}$ (shown as P in appendix A)
q	=	$\frac{\sigma_1 - \sigma_3}{2}$ (shown as Q in appendix A)
u	=	Excess hydroststic pressure
VS	=	Volumetric strain
α	=	Angle between the p-q diagram and the horizontal
ϕ	=	Angle of internal friction
γ	=	Dry density of the specimen
σ_3	=	Minor principal stress
σ_1	=	Major principal stress
$\sigma_1 - \sigma_3$	=	Principal stress difference (deviator stress)
σ	=	Normal stress
$\bar{\sigma}$	=	Effective normal stress

الخلاصة

في هذه الاطروحة بُحث تاثير السمنته (اضافة الاسمنت الى الرمل) على رمل محلى حيث أُجريت تجارب معملية على رمال مسمنتة . وقد دُرست خواص هذه التربة وعلاقة الاجهاد والانفعال وأُجريت اختبارات انضغاط ساكنة باستخدام طريقة المحاور الثلاثة وكان اسمنت بورتلاند هو المادة المسمنتة . وقد بُحث تاثير كل من الزمن الذى تحفظ فيه العينة فترة الانضاج ، ونوعية الحفظ ، وكمية ضغط الاحاطه ، وكمية الاسمنت ، ونوعية الاختبار ، وكثافة العينات . وقد أُجريت اختبارات على بعض العينات التى تم اختبارها ثم أُعيد تحضيرها دون اضافة اسمنت جديد لها بالاضافة الى بعض اختبارات أُجريت على عينات استُخدمت فيها كربونات الكالسيوم كمادة مسمنته وذلك لمقارنة نتائجها مع تلك التى استخدم فيها اسمنت بورتلاند وأيضا لدراسة بعض خواص هذه التربة والتى تمثل الى حد ما تربة الصبخات .

وقد حُضرت العينات في المختبر حيث يمكن التحكم في جميع المتغيرات وأُجرى نوعان من اختبارات الانضغاط : الاول منها يتم فيه اختبار العينات دون تشبيعها بالماء ودون السماح للماء بالخروج منها أو الدخول فيها . والنوع الاخر يتم فيه تشبيع العينات بالماء قبل اختبارها ثم يتمُ الاختبار حيث يسمح للماء بالدخول والخروج ، ويتم قياس كمية تغير الحجم بوساطة سحاحة . وقد وضحت بالرسم العلاقة بين المتغيرات المختلفة إذ تم استنباط بعض معاملات القوة مثل قوة التماسك وزاوية الاحتكاك الداخلي .

وقد دلت نتائج الاختبارات على أن التجفيف أثناء فترة الإنضاج يلعب دورا هاما في عملية السمنتة وخصوصا العينات التى أُستخدمت فيها كربونات الكالسيوم . فعندما يسمح للماء بمغادرة العينات أثناء فترة الانضاج تقل نسبة الماء تدريجيا مع الزمن وكلما قلت نسبة الماء كلما كانت قوة الاحتمال اكثر وكذلك معامل المرونة . وقد اثبتتْ التجارب أن قوة احتمال العينات ومعامل مرونتها يزيدان بزيادة مدة النضج ، وضغط الاحاطة ، ونسبة الاسمنت ، والكثافة .

ABSTRACT

In this thesis, the effects of cementation on a selected local dune sand have been studied under static loading. Stress-strain, strength and general characteristics of artificially cemented sands, were determined under different loading conditions, different cure periods, different cure types and different sample's density. The two cementing agents used were portland cement and calcium carbonate.

Artificially cemented sands were prepared in the laboratory where control over different parameters can be achieved. Unsaturated undrained static triaxial as well as drained static triaxial tests were performed on the artificially cemented sand specimens. Stress-strain and p-q diagrams were drawn and strength parameters (cohesion and angle of internal friction) were determined for all test samples.

The results show that the addition of a cementing agent to a wind-blown sand with uniform size distribution produces material with two components of strength - that due to the cementing agent itself and that due to the frictional component of the sand. Cemented sands distinguish themselves by having a well defined cementation/cohesion intercept while the angle of friction of a cemented sand is similar to that of uncemented sand. The results also show that drying process is essential in cementation development especially when calcium carbonate is used as an agent. The lower the moisture content at testing the higher the peak strength and initial tangent modulus values. Peak strength as well as initial tangent modulus values, increase with increasing cure period, confining pressure, cement content and density. Residual strength values seem to be independent of all parameters except confinement and density.

1. INTRODUCTION

1.1 General

Cemented soils belong to a class of material which can be labeled as either rocks or soils and they typically consist of wind blown deposits. Cemented sands form in many geological environments, including, but not limited to, marine deposits and dune deposits. In this thesis cemented soils can be defined as granular deposits bound together with a cementing agent and have measurable strength. Cementation effect can either occur chemically, physically or combination of both. The cement may either be present in the soil at time of deposition or may be formed after deposition by weathering of minerals present in the soil mass. The degree of cementation depends on factors such as the amount and type of cementing agent, water content, ground water movement, weathering and the way cementation effect was produced. Cemented sands are brittle at low confining pressures loosing most if not all of their strength after failure. This brittle response is critical especially during seismic loading, since it may lead to a sudden and total collapse when these soils are present in slopes. Cemented sands may be divided into two broad categories: naturally cemented and artificially cemented, depending on the way cementation effects are produced. The naturally cemented sands are found in various places in the world including the Arabian Peninsula. The distinguishing characteristics of these sands is their ability to stand in steep natural slopes and their apparent resistance to penetration noted during pile driving. Their ability to stand in steep slopes is often taken advantage of in slope construction and highway cuts, which reach up to 90° and often exceeding 100 ft (30 m) in height. Natural slopes in cemented marine terrace sands steeper than 40° and exceeding 150 m in height can be found [37]. Vertical or nearly vertical slopes in coastal cliffs of weakly cemented sands reach up to 180 meter in height [36]. Steep slopes in cemented soils are both natural and man-made. Naturally steep slopes are formed almost exclusively as a result of active erosion either along stream beds or along beaches. The most common natural cements found are: silica, calcium carbonate, clay, silts and iron-bearing minerals. The resistance and strength exhibited by these sands depend to a large extent on: amount and type of cementing agent present, sand density, degree of packing, and the characteristics of the sand itself. These characteristics include: grain size distribution, texture, shape, and mineralogy of particles [8, 10, 20]. The unconfined compressive strength of these materials, range from just slightly greater than zero to about 100 psi (700 KPa). The cementation in the sand is provided by small amounts of agents deposited at the point of contacts between sand particles. Cemented sands occur within Sabkha deposits where calcium carbonate and more recent diagenetic minerals, such as gypsum, serve as the main cementing agent [1].

The thickness of the cemented zones in a soil profile varies from place to place and in the same place from site to site. The degree of cementation ranges at times from highly (strongly) cemented to poorly (weakly) cemented zones [20]. The variability occurs not only on a small scale (within a sample or petrographical section), but also on a large scale over the entire stratigraphic interval of a particular formation [34]. The variation in cementation is usually attributed to unequal precipitation of calcite cement which results in variation of the degree of cementation. Undisturbed samples of these soils can only be obtained by extremely complicated and costly techniques, and therefore estimation of engineering parameters of these materials, for design purposes, are extremely difficult [14].

The artificially cemented sands are produced in the laboratory or in the field under controlled conditions. The literature reveals that artificially cemented sands made in the laboratory exhibit somewhat similar properties as those of naturally occuring cemented sands [8]. Testing of artificially cemented samples allows greater control over important variables that are normally difficult to assess in naturally cemented sands because of their heterogeneity, variation in cement content, and the difficulty normally encountered in sampling of naturally cemented sands. In this research an attempt has been made to present the static properties of only lightly cemented sands since that could provide the lower bound strength.

The wide use of cemented sands in airports, slopes, highways, etc. and the abundance of naturally cemented sands all over the world makes it necessary to understand the behavior and characteristics of such soils. Due to the difficulties in obtaining undisturbed naturally cemented samples and due to the heterogeneity of such samples, it will be difficult to obtain data that can be used for engineering purposes. This data, if obtained, will not be applicable to cemented sands in other areas because of differences in cementing agents, density and other characteristics. The effect of different parameters on properties of naturally cemented sands can not be investigated since there exist no control on such parameters, and the composition of each sample differs from that of other samples. In order to understand the observed behavior of cemented soils and to predict the response of these soils, a testing program has to be carried where the effect of different parameters can be studied. This testing can not be done on naturally cemented soil due to the above mentioned difficulties.

The best way to carry the testing program is to simulate field conditions by means of artificially cemented soils. A program of laboratory study was initiated on artificially cemented sands made in the laboratory under controlled conditions. Different parameters similar to what would happen in the field were tried. Cure period, cure type, confining pressure, density, saturation and remolding effects were considered during the investigation which covers the many variables that could be present in the field. Test results were expressed in the form of graphs where regression analysis, by means of the computer, were determined.

1.2 LITERATURE REVIEW

Cemented sands exist at various places in the world and the degree of cementation varies from very strong to very weak. The existence of such soils may create problems which should be considered when dealing with these soils. Strength of weakly cemented soils can easily be disturbed and reduced, and the degree of disturbance depends on many factors as will be discussed later. On the other hand, difficulties are encountered when dealing with strongly cemented soils for excavation purposes, since their high strength requires special tools to make the excavation. Saudi Arabia is one of these places where naturally cemented sands exist [29]. Weakly cemented sands exist in Western coastal plain. Hard cemented silty sands exist in Jubail area in the eastern coastal zone. Soft and loose surface subkha deposits exist in both western and eastern coastal and inland areas. These sabkhas, according to Akili, W. and Torrance, J. [1], consist of cemented and uncemented layers of varying thickness and properties. Cementing agents are mainly calcium carbonate and more recent diagenetic minerals [1].

The Arabian Gulf is one of the tropical and temporate regions of the world and cemented sands within carbonate sediments are very common in such areas where offshore oil is being produced [12, 30].

1.2.1 Weakly Cemented Sands

Experience and training are required in defining weekly cemented sands. Sitar [36] defined cemented sands as naturally occuring cemented granular deposits with measurable strength. Weakly cemented sands include deposits of loess, volcanic ash, dune sands, and marine beach sands. Cementing agents binds individual grains together, and cement may be either present in the soil at deposition, precipitate from percolating ground water, or formed by weathering of soil minerals. This cementation depends on: type and amount of cementing agent, water content, ground water movement, sand density, degree of packing, weathering and the characteristics of the sand itself. The characteristics referred to include grain size distribution, texture, shape and mineralogy [10, 20, 24, 28, 37, 40, 48].

Weak cementation in soils is rarely mentioned in the literature. Data on the strength and behavior of naturally cemented sands is limited and has become available in the late seventies. Table 1.1 shows the available information about naturally and artificially cemented sands. On the other hand, soil stabilization with chemical additives is known and has been used for long time. Additives like lime, lime-fly ash, portland cement and asphalt were used in many countries to stabilize soils for different construction purposes. The amount of cementing agent added is usually more than those percentages normally encountered in naturally occuring cemented sands. A great deal of information is available in the literature about stabilized soils and cement-treated soils. Engineering characteristics, mixing procedure, construction procedure, additive percentage, durability and uses are discussed in details in different publications [3, 23, 25, 31, 33, 35, 42, 44, 46, 47, 50, 52]. Since this research deals specifically with cemented sands, the discussion will be centered on these soils. Stabilized or cement-treated soils, will not be discussed here.

Table 1.1
SUMMARY OF AVAILABLE INFORMATION ON CEMENTED SANDS
(After Sitar 1979 [40])

	Alfi (1978)	Bachus (1978)	Korbin and Brekke (1975)	Mitchell (1976)	Salamone and others (1978)	Saxena and Astrico (1978)	Clough and others (1981)	Clough and others (1981)
Soil Tested	Naturally cemented sand	Naturally cemented sand	Artifically cemeted sand	Artifically cemented sand	Naturally cemented sand	Naturally cemented sand	Naturally cemented sand	Artificially cemented sand
Cementing Agent	carbonate and clay	Carbonate and Clay	Shaping wax	Portland Cement	Carbonate	Carbonate	Silicates, and iron oxides with minor carbonates	Portland cement
Sample Type	Hand trimed	Hand trimed	Compacted in molds	Compacted in molds	76 mm Denison sampler	76 mm Denison sampler	Hand trimmed	Compacted in molds
Type of Tests	Drained static triaxial	Drained static triaxial, indirect tension	Stati triaxial, indirect tension	Unconfined compression static tri-axial, in-direct tension flexure	Isotropically consolidated cyclic triaxial	Isotropic-ally conso-lidated undrained static triaxial	Unconfiend Drained triaxial and Brazilian tension	Unconfiend Drained triaxial and Brazilian tension
Stress Strain Curves Presented	Yes	Yes	Yes	Partial	No	Yes	Yes	Yes
ϕ,Degrees	48	39-42	11.5-35	30-45	37-39	37-39	37-49	29-41

Table 1.1 (Continued)

	Alfi (1978)	Bachus (1978)	Korbin and Brekke (1975)	Mitchell (1976)	Salamone and others (1978)	Saxena and Astrico (1978)	Clough and others (1981)	Clough and others (1981)
Dry Density. Kn/m^3	17.8	16.-17.1	16.7	N.A	11.8-15.7	11.8-15.7	16.5-17.6	14.6-16.9
Water Content,%	10.6	3.8-18.5	N.A.	N.A.	20-40	20-40	5-15	8
Unconfined Compression Kn/m^2	2700	60	337	1000-15000	N.A	N.A	50-1930	180-670
Approximate Strain at Failure,%	1.5	.6	.6	.35-3.0	N.A	2-23.5	N.A	0.37-5.07
Comments	Dynamic tests not done; high static strength	Dynamic test not done	Dynamic tests not done;soil has time-dependent response	Data is mostly in generalized form; no dy-namic data; post failure σ-ε data not available	Stress-strain curves not presented; unconfined comprensive strength unknown; effect of sample disturbance unknown	Stress-strain unlabeled; unconfined comprensive strength unknown; effect of sample disturbance unknown	Four different naturally cement soils were tested	2% & 4% portland cement were used

Note: N.A. = Not available

Sowers [40] classifies the cemented structures into two categories depending on the relative amounts of the binder and the bulky grains:

1. Matrix structure, where the volume of bulky grains is less than about twice that of the binder.

2. Skeletal structure, where the volume of bulky grains is more than twice that of binder. This will result in either contact bound or void bound:

   a. Contact bound, refers to the situation where the binder is concentrated between the points of contact of the bulky grains.

   b. Void bound, in which the binder occupies part or all of the void space between the bulky grains which are intouch.

Binding agents usually found in naturally cemented sands are; compressed and dried clay, calcium carbonate, various iron oxides and colloidal silica. Dense packing of sand grains can produce cementation [10, 30]. Mechanical interlocking of grains and capillary tension can produce an effect similar to that of cementing agents [9, 11, 24, 36]. Matrix of silt and clay particles can produce cementation which is a function of several factors such as the grain size distribution, amount of clay, type of clay minerals, nature of the saturating cations populations, and presence and solubility of excess entities as well as organic cementing agents [2, 8, 40]. According to Sridharan and Allam [2, 46] aggregation of soil particles and cementation by compounds of Ca, Mg, Al, and Fe result from repeated wetting and drying induced by large flocculations in the water content as the seasons change; which is the case in arid and semi-arid regions. Desiccation bonds have been found to influence the shear strength behavior of desiccated soils. Sitar [36] stated that the cementing agents along the Pacific beaches in California are clay, carbonates, minor gypsum and iron oxides.

When volcanic ash is combined with wind-transported soil and decomposed in the presence of water, cementation results upon drying of these soils. Sitar [36] stated that the cementation in volcanic ash soils in Guatemala seems to be caused by mechanical interlocking of the individual particles due to the fact that they are angular in shape with sharp edges.

Sitar [36] used portland cement to make artificially cemented sands. He used 2% and 4% portland cement by weight of the sample. Unconfined compressive strength was obtained for curing periods ranging from 3 to 28 days. Triaxial compression, Brazilian tension and static and dynamic unconfined simple shear tests were performed. Clough et al. [8] studied the behavior of four naturally cemented sands in the San Francisco Bay area in addition to artificially cemented sand. The naturally cemented sands vary from very strong to very weak. Thin section analysis of these sands showed that the cementing agents are basically similar and mainly consisting of silicate and iron oxides with minor amount of carbonates. Unconfined, drained triaxial and Brazilian tension tests were performed in their study. The authors concluded that density, grain size distribution, grain shape and grain arrangements have a significant effect on the behavior of cemented sands. They have also found that the behavior of naturally cemented sands can be depicted by the artificially cemented sands prepared in the laboratory.

Frydman [13, 14] concluded from his study on naturally cemented sands that the pressuremeter appears to be potentially a useful tool for measurements of in situ engineering parameters of clean and partially cemented sands. Triaxial tests were carried on cylindrical specimens cored from frozen blocks. Undrained cyclic strength was obtained using cyclic stress-controlled triaxial compression equipment for frozen specimens which were saturated using CO_2. X-ray photographs were also used to identify layering and degree of variability of the structure of the cored frozen specimens. Strength parameters and modulus of elasticity were measured in this study.

1.2.2 Cementation In Rocks

Cemention also exists in rocks. Limestones are rocks composed of clacium and magnisium carbonates, they are marine deposits. They are formed from soluble bicarbonate in water by biochemical and physicochemical processes. Silts, iron oxides, and volcanic ash may be present as impurities in the carbonate formation. Freshly deposited carbonate formations are characterized by their high void ratio. Cementation, due to the additional precipitation of carbonates that bond the grains, cause induration of the limestone. Replacement of the more soluble calcium carbonate by less soluble calcium carbonate, dolomite, and even silica often accompanies induration [18, 38, 39].

In sedimentary rocks cementing is the most important mechanism of induration. Calcium carbonate, silica, and iron bearing minerals precipitate in the voids and bind the solids together. Cementation can also be produced by a clay in dry climate as a result of desiccation bonds [20, 40].

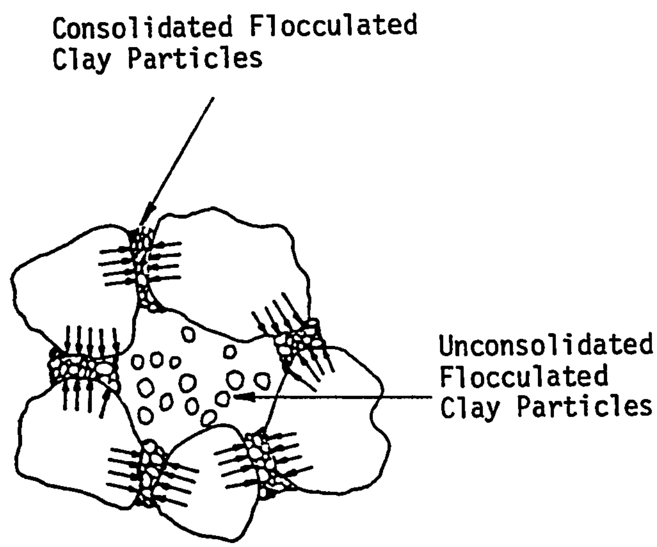
1.2.3 Cementation In Collapsing Soils

The presence of cementing agents in some soils' structures affect the behavior of these soils. The bridging effects create a honycomb structure with high void ratio and consequently low density, but substantially high strength due to the strength of the cementing agents. These soils at their natural water content will support a heavy load with negligible consolidation; but when water is added they experience large reduction in volume. These soils are known as collapsing soils. Collapsing, or metastable soils, have been found in many parts of the world. They exist in Europe, North and South America, parts of Asia, southern Africa, China, New-Zeland, Argentina and Uruguay [5, 6].

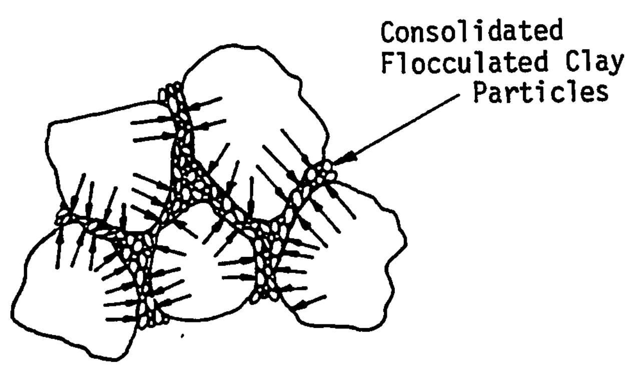
Dudly [9] defind collapsing soils to be soil deposits that were loessial, aeolian, subaerial, colluvial, mud flow, alluvial, residual, volcanic tuffs and man-made fills. Metastable or collapsible soils are defined by Clemence [7] as any unsaturated soil that goes through a radical rearrangement of particles and great loss of volume and strength upon wetting with or without additional loading. He also stated that collapsing soils are found in soil profiles from all types of sources; in mountainous areas, in the plains and in arid and humid areas. However all types of collapsing soils are weakened by the addition of water regardless of the physical basis of the bond strength. The bonds are weakened, softened or removed from the structure when enough water is added, which cause a new arrangement in the soil aggregation that causes reduction in strength, reduction in volume and increase in density as shown in Fig. 1.1.

Collapsing soils usually consist of loose structure of bulky-shaped grains in the form of silt to fine sand size bonded together by a cementing agent. Fig. 1.2 shows typical structures for such soils.

The collapse process requires an open, potentially unstable and partly saturated structure. Large enough applied stress is also required. The soil needs to have high enough value of soil suction, bonding, or cementing agent. The binding agent can be capillary forces which is usually the case with sandy soils with the presence of silts. Clay is another binding agent where clay grains cluster around the junction in a random flocculated arrangement giving a buttress



A - Soil grains before inundation



B - Soil grains after inundation

Fig. 1.1 Effect of Wetting on Collapsing Soils [17].

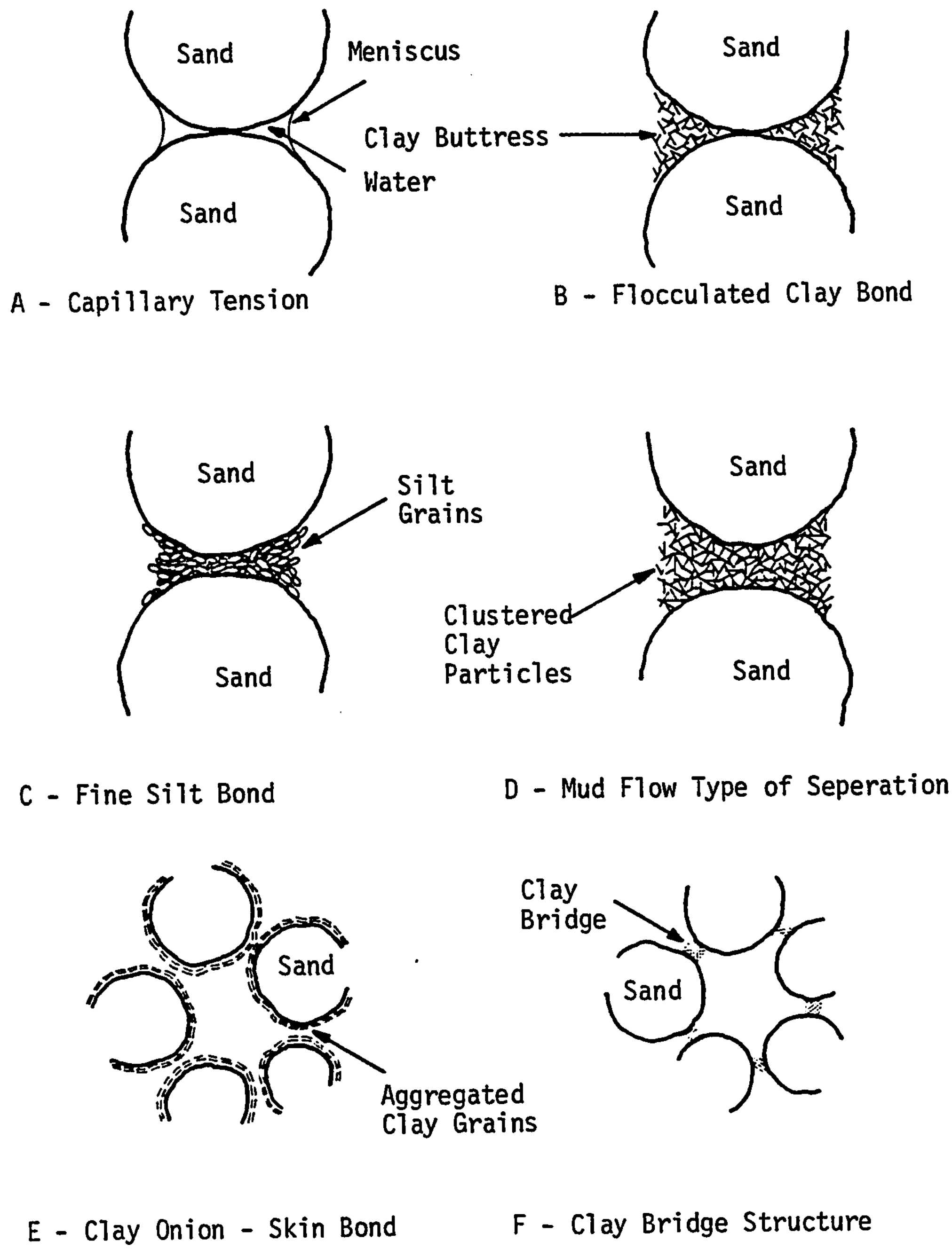


Fig. 1.2 Typical Collapsible Soil Structures [5, 7, 9].

type support to the bulky grain as shown in Fig. 1.2-D. The nature of the clay bond is complex and it is not clear how much is due to electrochemical effects and how much of it is due to capillary effects [5, 9]. Chemical cementation may exist also in some soils where inorganic materials such as iron oxides and calcium carbonates or the welding of the grain contact, provide strength for many collapsible soils [5, 7, 51].

In residual soils, the collapsible grain structure developed as result of leaching out of soluble and colloidal matter, results in high void ratio [6, 9]. Gibbs [15] suggested a method for identification of a collapsing soil. Gibbs states that a density with a void space larger than the space required to hold the liquid limit moisture content, could result in a soil that could be saturated to the point of exhibiting practically no plasticity and no strength; and subsequently may collapse. On the other hand, a soil with a void space less than the amount required for the liquid limit moisture content, would always be plastic even when saturated; and would not be subjected to collapse unless loaded [15, 19].

A typical example of naturally cemented collapsing soils is loess. The behavior of loess, specially their susceptibility to subsidence, is due to some extent to their peculiar structure. One of their main influencing factors, which is related to this research, is the characteristics of the bond between the solid particles, taking into account the influence of the liquid and solid components. According to Larionov [22] the compressibility of loess soils depends on the magnitude of the applied stress, the character of wetting (duration, quantity, pressure, chemicals contained in the water), and chemicomineralogical peculiarities of the loess soil itself.

Terzaghi [45] defines loess as uniform cohesive wind-blown sediments consisting of angular and subangular quartz that are slightly cemented together and the binder is the source of cohesion. According to Holtz [16], loess is a loose, wind-deposited soil generally composed of rather uniform silt-sized particles which are bonded together in an open arrangement by thin films of clay. Dudly [9] has mentioned that loess has a honycomb structure of silt with varying amounts of sand, clay, calcite grains, and other materials arranged in an open cohesive fabric which frequently results in a low natural dry density. Loess has a definite structural arrangement that gives it considerable strength in the undisturbed condition while at natural moisture content.

Taylor [43] defines loess as a fine-grained, air-borne deposit characterized by a very uniform grain size, a high void ratio, and a slight cementation which enables it to stand in nearly vertical slopes. Loess deposits are characterized by their uniform grain size and their pronounced vertical cleavage [40]. Cementation in loess is provided by a clay, calcareous materials, or deposition of calcium carbonate and iron oxides. These agents bind fine-sized particles (silt particles) to form a low density, rigid, and hard soil when dry, but soft and mushy when saturated [9, 24, 40, 49].

In a true loess, the cementation is destroyed when the soil is partially or fully saturated; therefore true loess deposits that have never been saturated, have high shear strength and will stand vertically in cuts as deep as 40-50 feet [40, 43, 45]. Modified forms of loess exist which retain some cohesion even when submerged. Generally, as the soil dries below the shrinkage limit the water remaining withdraws into the narrow spaces close to the junction of the soil grains, as shown in Fig. 1.2-A. The air-water interface in these capillary size spaces places the water under tension and increases the effective stress since the excess water pressure u is negative and $\sigma = \sigma - u$. However when water is added, u becomes positive and the effective stress decreases. Dissolved ions are also affected by the amount of water present. Concentration of ions tend to increase with decrease in water. This is coupled with increase in the strength as a result of build up in cementation bonds [9, 22].

2. METHODOLOGY OF RESEARCH

The experimental study undertaken here consists of preparation of cemented sand specimens in the laboratory and then allowing them to cure under controlled conditions before testing them utilizing the static triaxial test. During this study, different parameters were selected which would simulate the field conditions such as: confining pressure, different moisture percentages, age of specimens prior to testing, density and the effect of reconstitution. These different parameters may vary in the field one at a time or a change in more than one may occur simultaneously. In the laboratory, investigating the effect of each parameter was considered alone by keeping other parameters fixed. This permits consideration of the effect of each variable separately on stress-strain and strength properties of cemented sands.

2.1 MATERIALS

2.1.1 Sand

The sand used for the preparation of artificially cemented--sand specimens was dune sand brought from the UPM beach. The grain size distribution of the sand is shown in Fig. 2.1, its effective size (D_{10}) is 0.11 mm, medium grain size (D_{50}) is 0.33 mm and its uniformity coefficient C_U is 3.45. The sand may be described as uniform. The absorption capacity was determined according to ASTM C 128 and found to be 0.58% for 24 hours soaking. The specific gravity of the sand

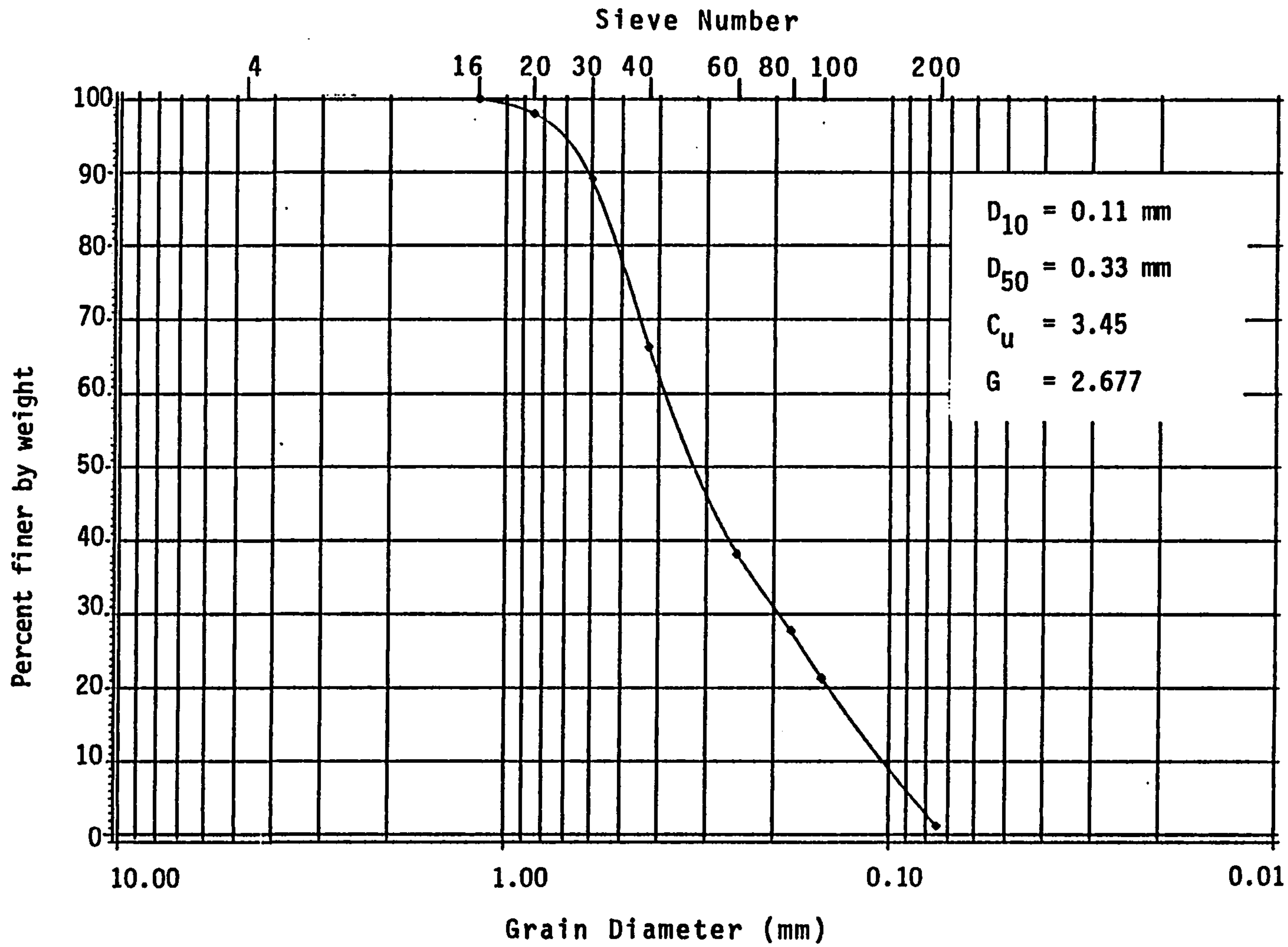


Fig 2.1 Grain Size Distribution Curve for Sand Used.

was determined for reconstituted samples in accordance with the gradation curve and it was found to be 2.677. In all samples, sand was reconstituted as per established gradation curve shown in Fig. 2.1. This was adhered in order to eliminate any effect of gradation or differences in fine content on experimental results.

2.1.2 Cementing Agent

The main cementing agent was portland cement type V which is a product of Saudi Cement Company and know as Dhahran cement. Calcium carbonate, in a powder form, was used at a later stage as another cementing agent.

2.1.3 Water

Distilled water was used during sample preparation (mixing) and for saturating samples in the drained triaxial testing phase.

2.2 PREPARATION OF SPECIMENS

2.2.1 Molds

cylindrical PVC molds, 146.8 mm (5.78 in) long by 72.4 mm (2.85 in) in diameter with a narrow, 1.5 mm (0.06 in) slit cut along one side, were used to prepare cylindrical cemented sand samples. The thickness of the mold was 7.9 mm (0.31 in) which provided high rigidity for the mold during specimens compaction. The exterior top and bottom rims of the molds were machined down to 12.7 mm on each side to provide smooth and uniform circular surfaces in order to fit a predetermined circular holes with an average diameter of 87.5 mm (3.44 in) in the base plate and in the mold collar. The mold was held together using 3 tout hose clamps, as shown in plate 2.1, to keep the slit closed during sample preparation in order to obtain uniform sample diameter through out the height and to ensure repeatability of the specimens diameter. During compaction, the base plate is firmly fixed to the compaction device with the bottom of the mold resting on the plate while the mold collar positioned on the top of the mold. The mold collar is held firmly to the base using ear-type clamps and steel studs as shown in plate 2.2. The mold is in between the collar and base and kept in vertical position, centered with the center of the compaction rammer. Expander location pin holes were drilled (3 mm deep) in the molds two on each side of the slit, as shown in plate 2.1, to be used with mold expander when extruding the specimens prior to testing.

The molds used to prepare samples for instantaneous testing (i.e. zero age specimens) have two narrow 1.5 mm longitudinal slits in opposite sides of each mold. This was adopted to avoid any disturbance of the specimens when extruding them. It is reasonable to assume that no hydration would taken place in this short period of time, and therefore no cementation bonds would developed. Consequently, no significant strength would be gained in this short period of time. Strips of metal having the same thickness as the slit, were provided in place of the slits to avoid diameter irregularities. The

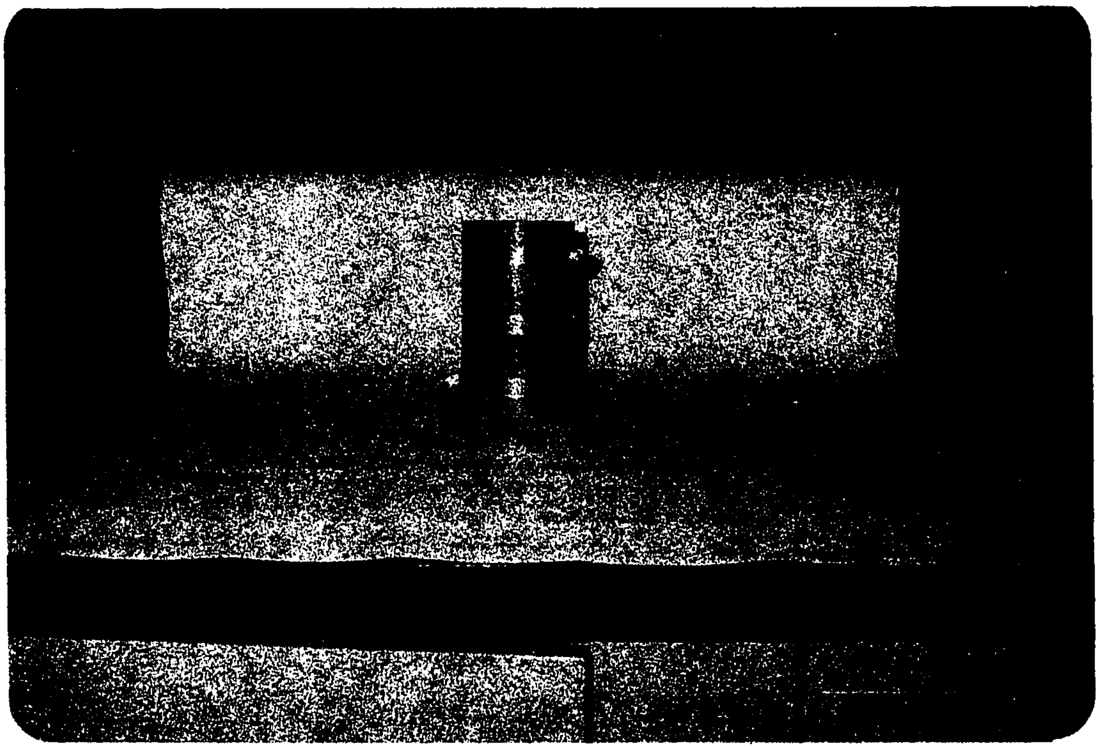


Plate 2.1: Mold held with three tought hose clamps prior to sample's compaction.

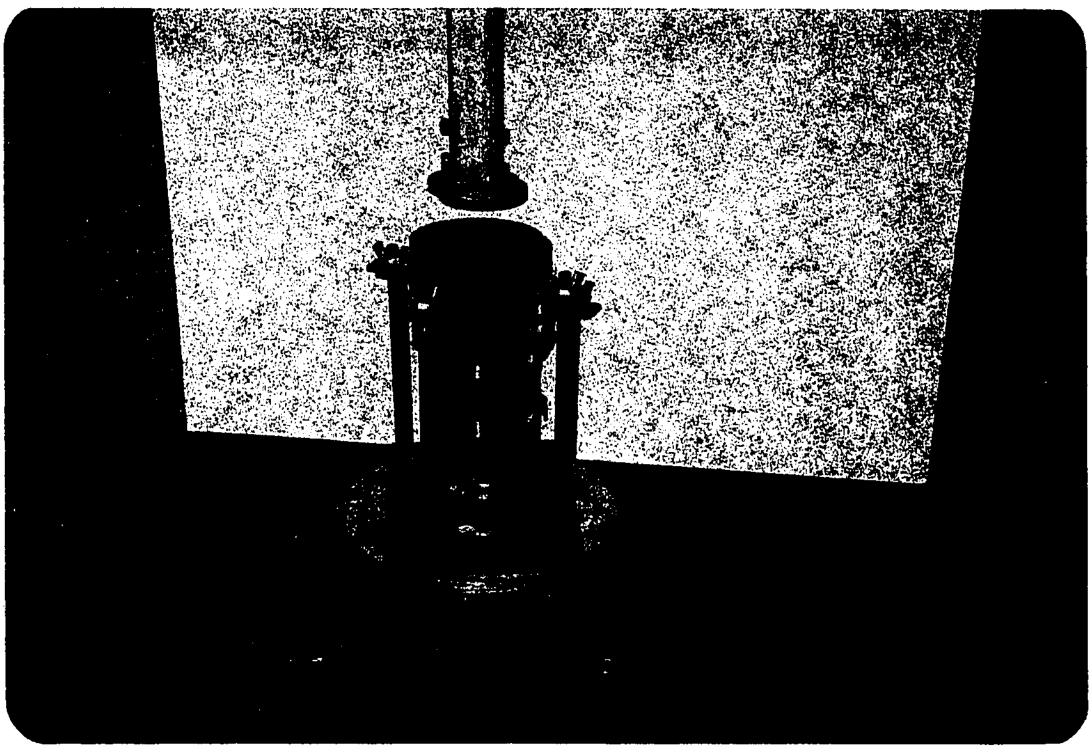


Plate 2.2: Specimens compaction set-up.

above procedure used for molds with one slit was adopted as well when using molds with two slits in preparing cemented sand samples.

2.2.2 Compaction Device

Mechanical rammer was used to compact specimens. The rammer has a circular base of 69.3 mm (2.73 in) diameter, base thickness of 8 mm (0.31 in), a weight of 2.42 kg (5.33 lb) and a free fall of 304.8 mm (12 in). The rammer's diameter (69.3 mm) is smaller than that of the mold (72.4 mm) which results in a reasonable clearance between the rammer and the mold inner surface. This prevented any possible contact between them that could reduce the energy during compaction. Additionally, no rotation of the base and/or mold was allowed during compaction. With the above mentioned rammer's diameter a complete coverage of sample's surface during compaction was achieved.

2.2.3 Mixing and Compaction

The following procedure was followed in preparing all specimens, where repeated results were insured. The procedure is summarized in these steps:

1. sufficient amount of selected sand for two specimens (2400 grams) was reconstituted according to the grain size distribution curve shown in Fig. 2.1, weighing accurately all fractions.

2. Dry cementing agent (portland cement type V or calcium carbonate) was accurately weighed depending on the percentage required. This percentage is based on the dry weight basis of the sand (i.e. 2% cement means 100 parts of sand and 2 parts of cement by weight, and the same for other percentages).

3. The cementing agent was added to the dry sand and thoroughly mixed in by hand.

4. The mix was then poured slowly (to avoid losses of fine particles) into the bowl of a mechanical mixer.

5. The molds were cleaned, numbered, and accurately weighed. The first one (sample A) was then assembled into the compaction machine.

6. A predetermined amount of water (192 ml) was added, and the material was throughly mixed for about 5 min. using the mechanical mixer.

7. The wet mix was poured into a plastic bag to avoid moisture loss.

8. Predetermined amount of the mixture was weighed and divided equally into three separate mixing bowls.

9. Each sample was compacted in three equal layers (each layer is a bowl's content). The top of each compacted layer was scarified to a depth of about 4 mm before the following layer was placed. The number of blows (15 per layer) was maintained through out except for those samples where the density was the variable; where the number of blows per layer ranged from 3 to 25.

10. The mold was dismounted. The top of the sample was carefully trimmed even with the top of the mold using a straight and sharp edge. In all samples made the bottom was smooth and even with the mold.

11. The sample with its mold was weighed, identified and stored for later use. Prior to storage, some samples were wrapped in plastic sheet and dipped in paraffin wax to prevent moisture loss. Other samples, which were to be cured without wrapping and coating with wax, were allowed to dry up gradually at room temperature until testing time.

12. The compaction of the second specimen (sample B) was done next, and the same procedure as in sample A was followed. The elapsed time between mixing and molding of the first and second specimen did not exceed 25 min.

13. The extra mix which remains after preparation of both samples, was used for moisture content determination of the mix. Moisture content of each specimen after testing was also determined.

2.2.4 Curing of Specimens

The artificially cemented specimens were produced in the laboratory under controlled conditions, and were allowed to cure at room temperature for a specified period. During this period, specimens were placed on the bench with their longitudinal axis in the vertical position. They were flipped every other day by placing them up side down to ensure uniformity of moisture distribution. Three types of curing were applied:

I. In-Wax Curing

After the specimens were prepared, their weight was determined, they were wrapped in a thin plastic sheet, and coated by immersing them in a molten paraffin wax at approximately 52±3 C°. In this way no water was allowed to egress and the moisture content was kept at approximately the compaction moisture content. Samples in this category were permitted to cure at room temperature for the specified periods. Minutes before testing the wax and plastic wrapping was removed and sample's weight was determined. This weight was compared with the previous weight (after the compaction but before wrapping) to insure that no loss in moisture content has occured. Thus moisture content was kept constant through out the curing period. Samples were then tested as will be discussed later.

II. Curing without Wax

After the specimens were prepared, their weights were recorded and were allowed to cure in the laboratory at room temperature. They were not coated with wax and therefore water was allowed to egress, and consequently reduction in moisture content occurs. Shortly before testing time, specimen's weights were determined again, recorded and compared with the original weight. The difference between the two weights is a measure of moisture loss. Afterwards, samples were tested as will be discussed later.

III. Curing in and out of Wax

Some of the samples treated with calcium carbonate were allowed to cure differently than those previously discussed. They were wrapped in plastic sheet, coated with paraffin wax and allowed to cure at room temperature conditions for one week. Wax and plastic wrapping was then removed and specimens were permitted to cure at room temperature conditions for another specified period without wax. Samples were later tested as required.

2.2.5 Extrusion of Specimens

The main purpose of the preliminary study undertaken initially was to select a sample preparation method which is easy, reproducible and with minimum sample disturbance. Extrusion of specimens was one of the main problems. Several types of molds such as steel, brass and PVC were tried and it was found that cemented sand sticks to both steel and brass molds but not to PVC molds. Painting of PVC molds with any type of oil was not required and loss of sand particles during extrusion was of negligible amount. The only remaining problem concerning sample extrusion was how to open such a rigid mold (molds with only one slit). The tapered steel wedge shown in Fig. 2.2 was tried where the sharp side was pushed against the slit in the mold and as it penetrates more the slit opening gets larger. The tapered wedge was allowed to penetrate to about 6-7 mm through the mold thickness. Any further penetration was prevented by the welded steel bars located at each side of the wedge at about 7 mm from the sharp edge. These bars will hit the sides of the slit and will not allow any further penetration. The wedge method had one disadvantage namely when pushing against the mold some sample disturbance could result. Thus other options were considered and finally I came up with the mold expander shown in plate 2.3. Extrusion of specimens was carried out easily without any disturbance and with enough clearance between sample and mold surface which minimized particles' loss.

After the specimens had cured for the specified period, the wax and plastic wrapping (if added) was removed. The specimen was

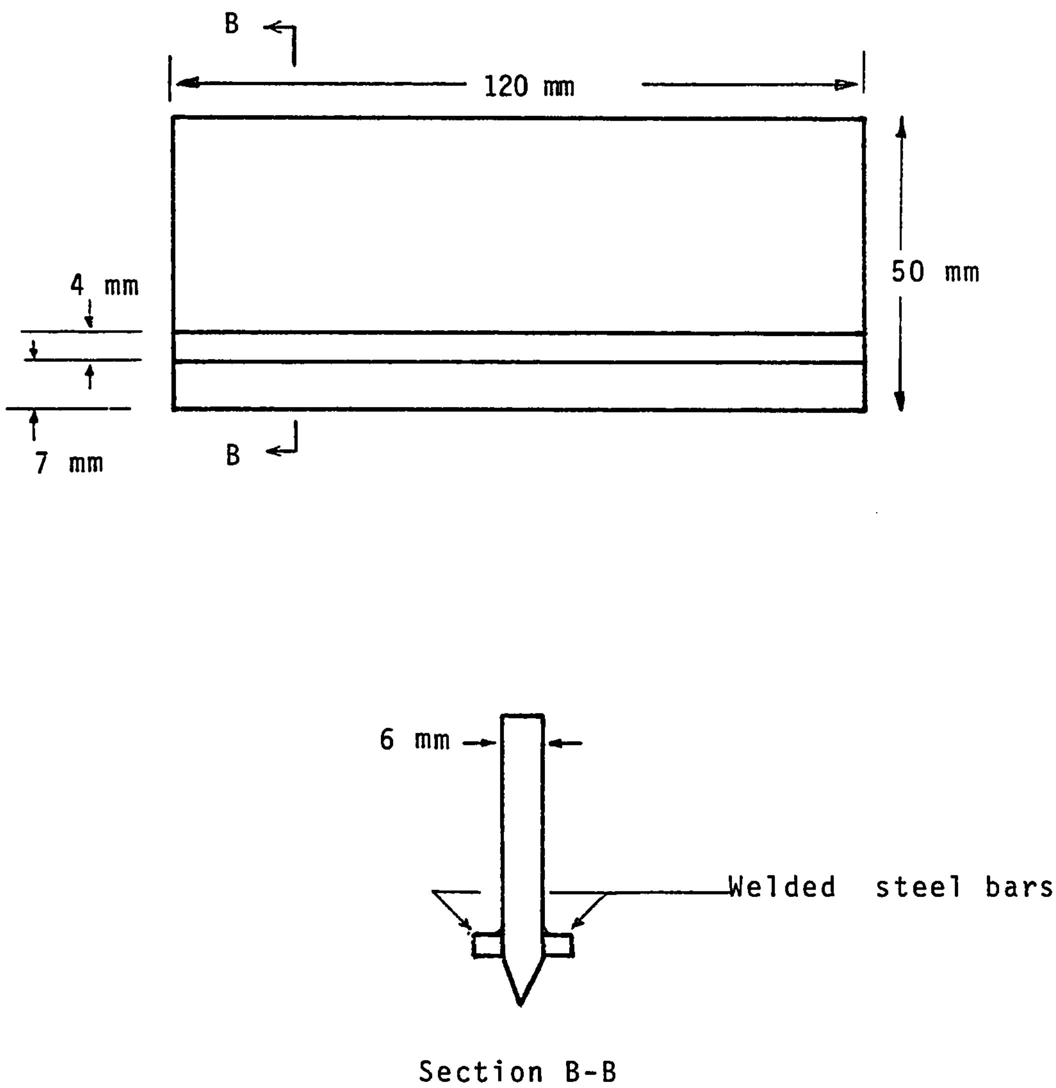


Fig. 2.2: Diagrammatic sketch showing the steel wedge.

Plate 2.3: Mold expander used to extrude specimens (length and internal diameter are 100 mm each).

then weighed and the length was measured while in the mold. The hose clamps were loosened and the mold was carefully mounted in the mold expander. The mold expander (100 mm in diameter and 100 mm long), fabricated in the UPM research shop and shown in plate 2.3, consists of two halves of a steel tube hinged together along a longitudinal axis and provided with two separation screws along a diameteral axis. On either side of the non-hinged axis, two locating pins protrude towards the center of the expander. The locating pins can be screwed down until they match the pin holes of the mold. The expander is forced to expand using the separation screws pushing the two halves of the mold apart. As a consequence, the mold will open up sufficiently along its slit to permit placement of a 4 mm wedge as shown in plate 2.4. The separation screws are then loosened and the mold is removed from the expander while protecting the bottom of the samples using a perspex plate. In this manner any sliding movement of the sample is prevented and the sample is positioned vertically while resting on the perspex plate. Afterwards, the mold is pulled up vertically keeping a clearance between the mold's surface and the sample thus minimizing the loss in particles flaking off the sample. The diameter of the sample was measured at the bottom, middle and top, taking two measurements (at right angles to each other) at each level. An average diameter was calculated and recorded. The sample would then be placed on the triaxial cell base with its bottom during compaction being its bottom during testing and the test would be carried out as described in chapter 3.

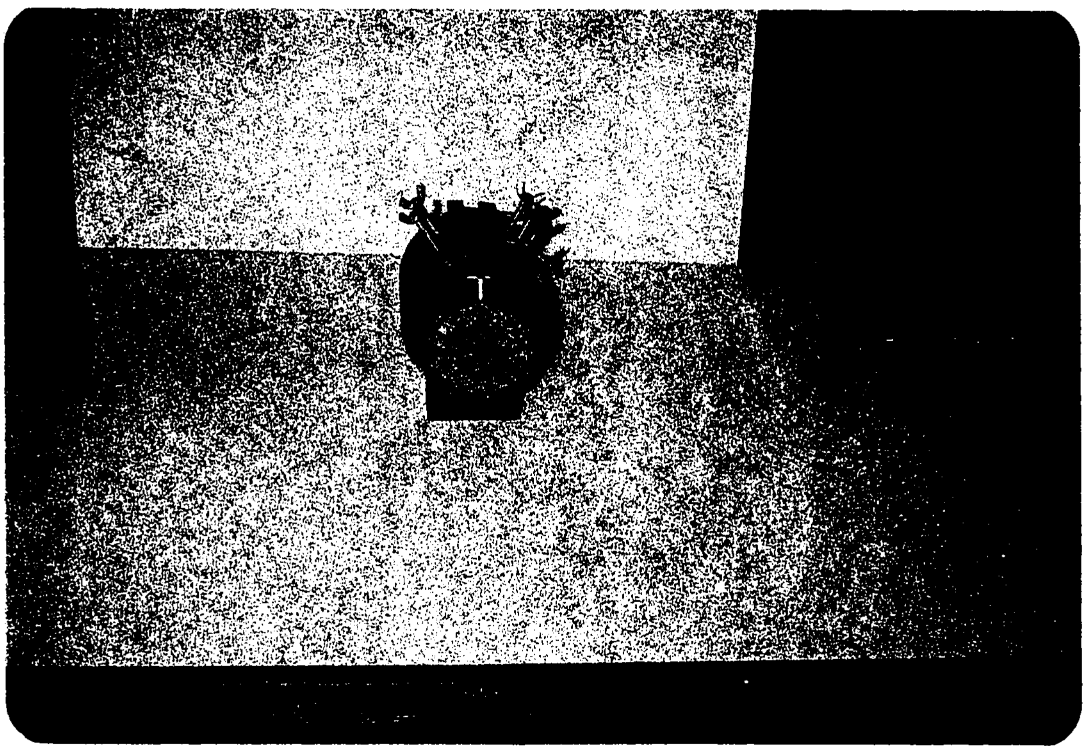


Plate 2.4: 4mm wedge inserted into the slit of the mold to keep the mold open while removing the mold expander.

For samples prepared in molds with two narrow slits (i.e. zero age samples) the mold expander was not used; because after the hose clamps were removed the two halves of the mold were easily separated permitting removal of sample.

3. EXPERIMENTAL INVESTIGATION AND ANALYSIS

3.1 EXPERIMENTAL INVESTIGATION

3.1.1 Objectives

The main objectives of the study undertaken here is to simulate naturally cemented sands by means of a laboratory procedure, test these artificially cemented sands utilizing the triaxial test and derive useful laboratory-based information on their stress-strain and strength behavior under static loading. More specifically the objectives are:

1. To develop a suitable, easy, and reproducible process of preparing artificially cemented sand for triaxial testing purposes.

2. To determine compositional effects such as: type and percent of cementing agent, sample density, water content, etc. on generalized stress-strain behavior of artificially cemented sands.

3. To investigate the effect of cure time, type of cure, aging, confinement and saturation on the behavior of these sands as depicted by the static triaxial test.

4. To characterize reconstituted samples (initially cemented but pulverized and recompacted) on stress-strain and strength behavior.

3.1.2 Experimental

Artificially cemented sand samples were prepared according to the procedure discussed previously and tested under static triaxial conditions. Sample's stress-strain and general strength characteristics were determined. Summary of the test program covered in this research is shown in table 3.1. The bulk of tests was carried out on fresh samples. These samples were prepared, allowed to cure and finally tested. On the other hand few tests were carried out on reconstituted samples. These samples were obtained by breaking down the tested samples (samples originally mixed with 2% portland cement) into small pieces and allow them to dry completely. Samples were then remixed with approximately 8% water and no cementing agent was added. Specimens were prepared and compacted in the same way as in chapter 2, and then allowed to cure prior to testing.

In samples shown in table 3.1 repeatability of results was achieved and checks were done for most of specimens as will be seen in the results. Two types of triaxial tests were performed:

1. Unsaturated Undrained Triaxial Tests, in which no water was added to the sample and no drainage was permitted. The samples were mounted on the triaxial base which was

TABLE 3.1 SUMMARY OF LABORATORY TESTING PROGRAM

	Cement Content	Triaxial Test Type	Cure Period, days		Confining Pressure KPa	No. of blows per Layer	Type of Specimen
			In Wax	Out of Wax			
Portland cement type V	1% 3% 4%	Unsaturated Undrained	7,14		69	15	Fresh samples
	2%	Unsaturated Undrained	0,1,3, 7,14, 28,56	0,1,3, 7,14, 28,56	69	15	Fresh samples
		Unsaturated Undrained	14		69,138,207, 276	15	Fresh sample
		Unsaturated Undrained	14		69	3,6,10, 15,20, 25	Fresh sample
		Drained	14		69,138,207 276	15	Fresh sample
		Drained		7,14,28	69	15	Fresh sample
		Unsaturated Undrained	7,14		69	15	Recons-tituted samples
Calcium carbonate	2%	Unsaturated Undrained	7,14	7*,14*, 28*	69	15	Fresh samples
	3%	Unsaturated Undrained	7	7*,14*	69	15	Fresh samples
	4%	Unsaturated Undrained		7*,14*	69	15	Fresh samples

* Samples were allowed to cure in wax for 7 days

specially made to accommodate larger diameter (75.3 mm) than that of the specimen in order to take care of the increase of the area of the specimen during the test. The cap was placed on top of the specimen and the specimen was enclosed by a 0.30 mm (0.012 in) thick rubber membrane using a membrane stretcher. Rubber O rings were provided at both the top and bottom of the sample to tighten the membrane to the base and cap in order to prevent any leakage. The upper assembly of the triaxial cell was positioned carefully maintaining the tip of the plunger in contact with the center of the cap. All top nuts of the vertical rods were tightened properly and the triaxial cell, with the sample in it, was mounted onto the triaxial apparatus. Deaired water was permitted to enter the cell (outside the specimen) untill the cell was full. The water supply valve was closed and the required confinement was applied by means of deaired water using Bishop's type self compensating mercury control apparatus. A schematic diagram of the mercury control apparatus is shown in Fig. 3.1. Deviator stress was applied at a selected rate as the loading platform (under the triaxial cell) moves upward at a controlled speed of 0.66 mm/min (0.026 in/min). Readings of the deformation dial as well as the loading dial were recorded. During this test no drainage was permitted and all valves were kept closed. At the end of the test, the specimen's mode of failure was noted

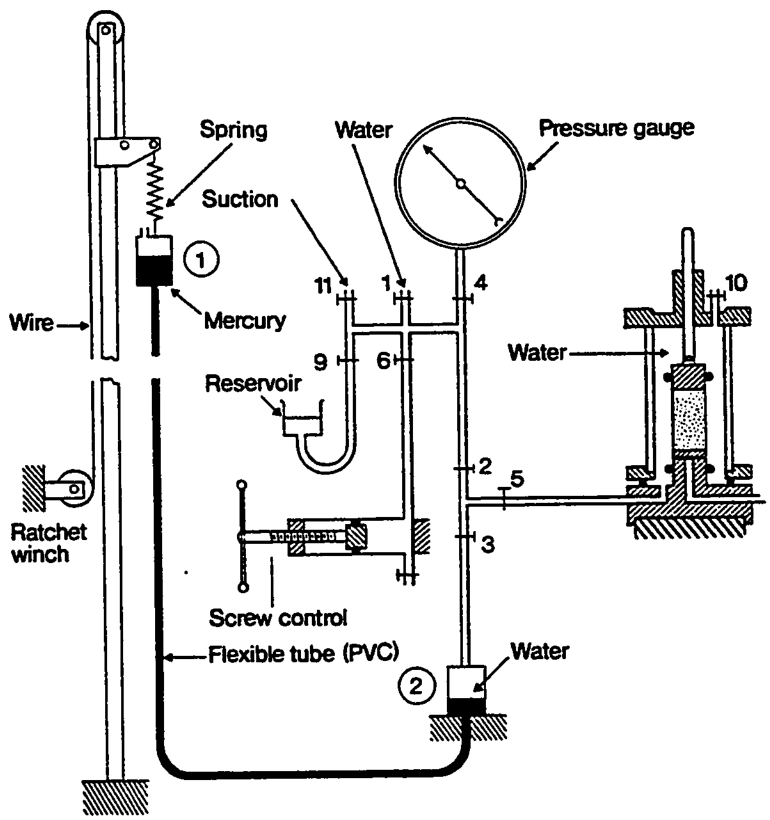


Fig. 3.1: The basic layout of self-compensating mercury control.

and photographs for some specimens were taken. The specimen was then removed and representative sample for moisture content determination was obtained. In some cases, the whole sample was taken for moisture content determination. A schematic diagram of the triaxial cell is shown in Fig. 3.2.

During the preliminary study, it was noticed that while loading the specimens, and near the peak deviatoric stress value an increase in the confining pressure occured which was observed through the pressure gauge. This was of big concern because it is known that the triaxial test results are dependant to a large extend on the confining pressure level. Several solutions were tried inorder to overcome the problem and finally it was found that while loading the specimens and prior to the peak stress, samples expand a little causing displacement in the tube which transmits deaired water to the triaxial cell. This forced the water to push onto the mercury in cylinder No. 2 forcing it to go to cylinder No. 1. Because the flexible PVC hose between the two cylinders had a small diameter (2 mm), it did not accommodate the high rate in volumetric expansion and the pressure build up which was indicated in the pressure gauge. Finally the 2 mm PVC tube was replaced by 4.8 mm flexible tube which accommodated the volumetric change without any noticable increase in the confining pressure.

2. Drained Triaxial Tests, where some of the samples were

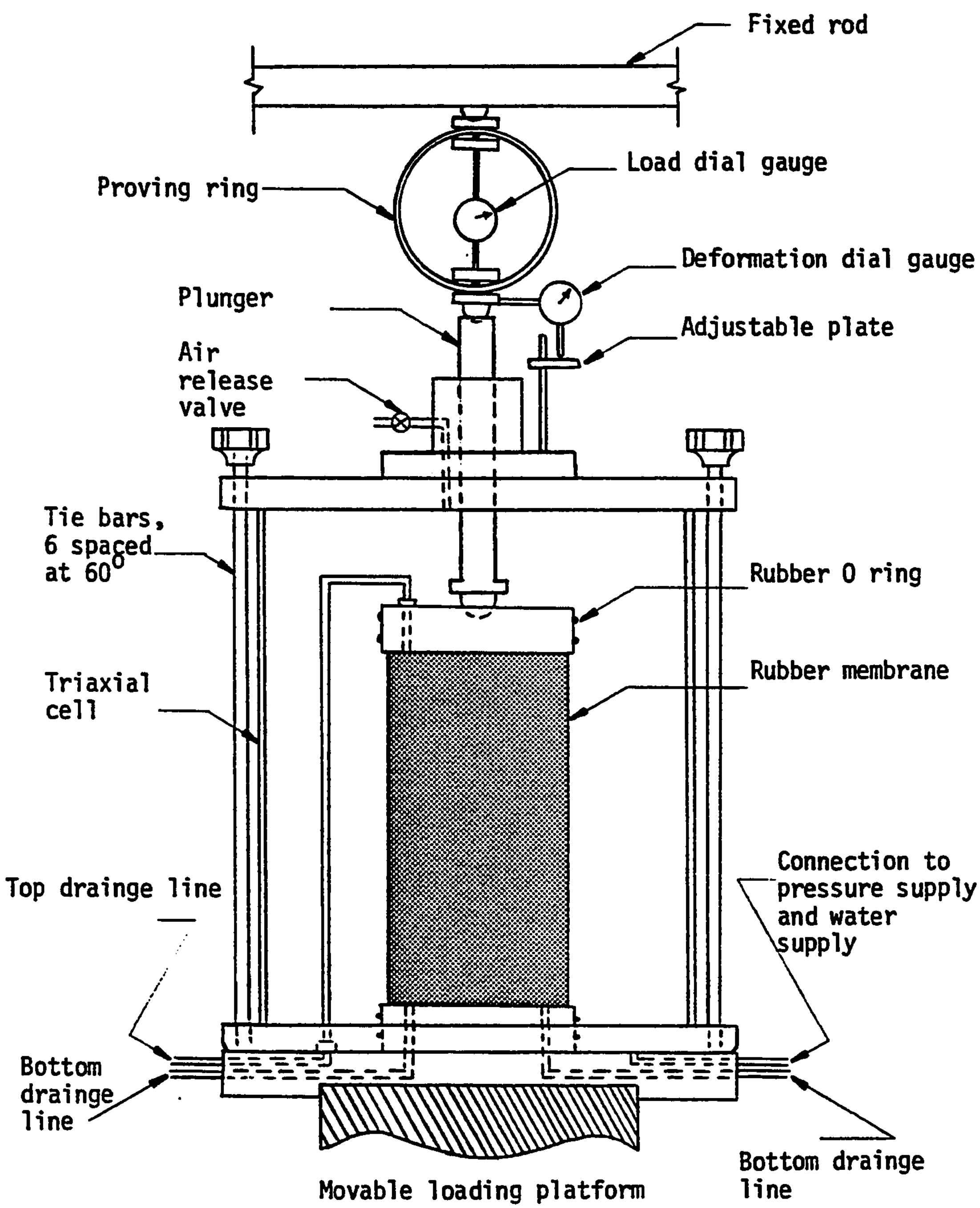


Fig. 3.2 Schematic representation of the static triaxial testing set up.

saturated by means of carbon dioxide with back pressure, were performed. The procedure for the test was as follows:

a. Special brass base was made with a diameter slightly larger than the sample. The porous stone; 71.12 mm (2.8 in) diameter was inserted inside the base keeping the surface of both, the stone and the base, at the same level, resulting in no gap or clearance left between the stone and the base. The base and the stone were made to have the same level and not to have any gap in-between to avoid irregularities in the loading surface which would increase the friction during specimen's expansion. Additionally, the higher part could punch through the specimen. This would also insure uniformly loaded specimen; because if a gap exists no stress will result in that portion. A similar aluminum cap was made in the same way and typical arrangement of both is shown in plate 3.1. Proper drainage connection were made in both of them.

b. Prior to testing, the porous stones were saturated by placing them under water and allowing them to boil for at least 15 min. The hoses in the base were filled with deaired water to replace the air. Afterwards, the porous stone was placed at the base, and the sample was placed on top. The cap with its porous stone was then

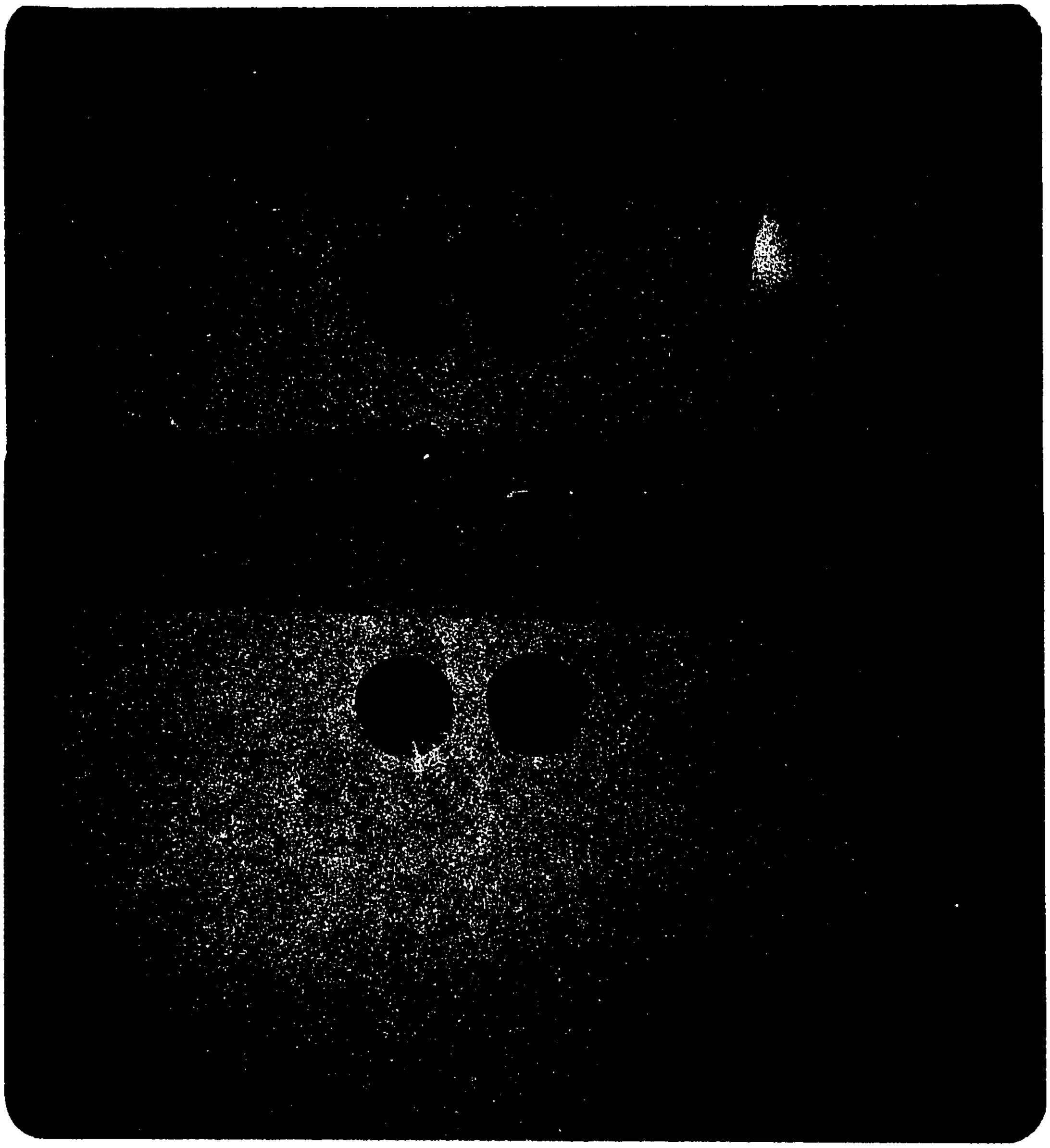


Plate 3.1: Brass base and aluminum cap with porous stones used for the triaxial cell.

placed and the membranes is assembled as in previous method. Rubber O rings were also provided. The drainage tube attached to the cap, was properly connected to the outlet valve, and the upper assembly of the triaxial cell was placed as in previous procedure.

c. Confinement was provided by means of deaired water under an initial hydrostatic pressure of approximately 13.8 KPa (2 psi) as a result of a constant head of an elevated water reservoir that supplies the triaxial system in the soils laboratory.

d. In order to expedite sample's saturation, carbon dioxide was permitted to flow through the specimen where it inters from the bottom of the specimen and leaves through the top. This flow process was maintained for about 15 min. for each and every sample tested. Deaired water from the elevated reservoir was then allowed to flow for about five minutes under a static head of approximately 13.8 KPa (2 psi), thus forcing any gas in the sample (presumably carbon dioxide) out through the top drainage line.

Carbon dioxide was used because the ability of such gas to be dissolved in water at a low pressure is much higher than that of air [26, 32]. Using the carbon dioxide will not require high back pressure and consequently time to saturate samples will be reduced appreciably while obtaining high degree of saturation.

e. As soon as the cell and the sample itself became full with deaired water, the top drainage line was connected to a pore water pressure device and a burette (for volumetric change measurement readings) through a 2-way valve; while the bottom drainage line and the triaxial cell line were connected to a pressure applying device where pressure can be applied and measured through a pressure gage.

f. Afterwards, the top drainage line, connected to the sample, was closed while the bottom drainage line of the sample was opened and a back pressure was applied gradually. A 69 KPa (10 psi) pressure was added every 3-4 minutes until 345 kPa (50 psi) pressure was reached. This was kept for 20 minutes. The back pressure applied and maintained both inside and outside the specimen, means that no differential stress was imposed on the specimen and the effective stress was maintained constant.

g. The back pressure was then reduced gradually at a rate of 69 kPa (10 psi) every 3-4 minutes untill zero back pressure was reached. The zero back pressure conditions was maintained for for 5-10 minutes before applying confining pressure. The lower drainage line connected to the sample was closed and the required confinement was applied. To measure sample's pore pressure, the upper drainage line was opened to the pore pressure gage -a part of the pore pressure device- while maintaining the volume measure device closed. After measuring pore water pressure in samples, the Skempton's pore pressure parameter (B) was computed where

$$B = \frac{\text{measured pore water pressure}}{\text{applied confinement}} .$$

B was found to be 97% or above in all samples tested. The high value of the back pressure applied may not be required for all specimens but done so to insure high degree of saturation.

h. After insuring relatively high degree of sample's saturation, the burette (the volume change measuring device) reading was noted and the 2-way top drainage line valve was opened to the burette permitting the sample to consolidate for about 5 min, under a selected confining pressure. The burette reading, at the end of the 5 min. period, was noted and was later considered in calculating the new specimen's length, the new specimen's volume and the new cross-sectional area.

k. Thus testing was resumed by applying the deviator stress in the same way at the same rate used in the unsaturated undrained tests, and reading the deformation dial gage, load dial gage, and the burette until the test comes to an end. The rest of the procedure is the same as that of the unsaturated undrained tests, discussed previously.

3.2 ANALYSIS

3.2.1 General

The UPM computer was used in the analysis of all samples. Data obtained from the Laboratories were fed into the computer and two programs were developed to handle these data. The programs are listed in appendix A. The SAS (statistical analysis system) programs were used to calculate slopes of straight lines, to find the modulus of elasticity, to draw the best fit curves for all shown plots in this thesis (based on regression analysis) and to predict all the provided equations for some of the results when applicable.

3.2.2 Unsaturated undrained Triaxial Testing

In this type of testing no water was added to the specimens and no drainage was allowed, and therefore it was assumed that the volume of the sample did not change during testing. This assumption was not perfectly true since the samples are not saturated and therefore contain air in the voids and the air is a compressible fluid. On the other hand, volumetric change due to air compression is small and does not affect stress-strain behavior of specimens when neglected, since volumetic changes were not measured. An alternative scheme to the use of Mohr circle for plotting the state of stress in soils is to plot a stress point whose coordinates are:

$$p = \frac{\sigma_1 + \sigma_3}{2} \qquad \text{and} \qquad q = \frac{\sigma_1 - \sigma_3}{2}$$

This approach was adopted to calculate and represent stresses generated from the experimental data.

3.2.3 Drained Triaxial Testing

In this type of testing the samples were saturated by means of CO_2 and back pressure. This procedure was adopted from Mulilis [27] and Frydman [13]. Samples were allowed to consolidate under an effective stress equal to the confining pressure. This consolidation reduces sample's volume, and its effect was considered in the calculation of the new sample's dimensions.

4- TEST RESULTS

4.1 Introduction

The Laboratory testing program was carried out on artificially cemented sands which were prepared under controlled conditions. The literature reveals that artificially cemented sands made in the laboratory exhibit somewhat similar properties as those of naturally occurring cemented sands [8]. The cementing agents used in this investigation were portland cement and calcium carbonate. The majority of the laboratory tests were performed on specimens with portland cement being the cementing agent. Extensive preliminary tests were done to establish the initial material properties and laboratory procedures including mold material and size, mixing procedure, compaction, curing, testing and saturation.

The effect of different parameters, on strength and deformation of laboratory prepared cemented sands were determined by varying one parameter at a time while holding the rest constant. Experimental variables were: type and amount of cementing agent, method and duration of cure, level of confinement, molding density and water content at testing time. Tests were run under full saturation condition versus some in unsaturated condition.

4.2 PORTLAND CEMENT

4.2.1 Effect of cure type

The effect of two types of cure namely in wax and out of wax on artificially cemented sand was studied in this research. The curing period for both types of cure, was varied while all other parameters were kept constant to eliminate their effect. The test parameters were: 2% portland cement, 69 KPa (10 psi) confinement, an average density equivalent to 96.8% of the standard Proctor density which resulted in sample's densities ranging from 17.15 KN/m^3 (109.06 pcf) to 17.29 KN/m^3 (109.94 pcf). Cure periods of 0, 1, 3, 7, 14, 28 and 56 days were tried with the two cure types (in wax and out of wax) at room temperature conditions. Unsaturated undrained triaxial test results are tabulated in table 4.1 for samples cured in wax and in table 4.2 for samples cured out of wax. Stress-strain curves derived from triaxial tests carried out on those samples are plotted in Fig. 4.1 for samples cured in wax and in Fig. 4.2 for samples cured out of wax.

Figure 4.3 shows peak deviatoric stress values derived from unsaturated undrained triaxial tests versus cure period on a natural scale for both types of cure and for various periods of cure. Figure 4.4 shows the same data on a logarithmic scale but up to 28 days cure period where zero cure time was replaced by 0.1 days. The moisture content remained constant for samples cured in wax while decreased with time for samples cured out of wax. Figures 4.5 and 4.6 show the

Table 4.1: Results of Unsaturated Undrained Static Triaxial Tests of Cemented Sand Samples with 2% Portland Cement, Cured in Wax for Different Periods and Tested at a Confining Pressure of 69 KPa.

Sample No.	Cure Period days	Dry Density KN/m^3	Percent Compaction %	Final Moisture Content %	Peak Strength $\sigma_1 - \sigma_3$ KPa	Peak Strength Axial Strain %	Residual Strength $\sigma_1 - \sigma_3$ KPa	Residual Strength Axial Strain %	Initial Tangent Modulus MPa
(1)	(2)	(3)	(4)*	(5)	(6)	(7)	(8)	(9)	(10)
S-224-A	0.0	17.15	96.64	7.82	302.89	2.29	252.34	11.31	59.04
S-224-B	0.0	17.16	96.69	7.58	311.91	2.47	262.97	9.43	57.90
S-207-A	1.00	17.20	96.93	7.64	356.60	1.40	216.67	8.22	85.28
S-208-A	3.00	17.17	96.78	7.30	436.14	1.76	265.18	8.21	122.28
S-205-A	7.00	17.15	96.65	7.48	476.58	1.40	333.41	5.84	133.11
S-211-A	14.00	17.16	96.70	7.34	531.97	1.23	339.18	4.92	157.40
S-219-B	14.21	17.19	96.88	7.31	532.35	0.87	330.31	9.26	154.40
S-227-A	14.83	17.14	96.61	7.28	537.70	0.78	319.58	8.83	156.59
S-201-A	27.67	17.21	97.02	7.36	566.90	0.96	351.66	4.70	163.30
S-218-B	56.33	17.22	97.07	7.37	604.45	0.70	380.54	5.46	172.50

Note: 1 KPa = 0.145 psi; 1 KN/m^3 = 6.36 pcf

* Based on standard Proctor

Table 4.2: Results of Unsaturated Undrained Static Triaxial Tests of Cemented Sand Samples with 2% Portland Cement, Cured Out of Wax for Different Cure Periods and Tested at a Confining Pressure of 69 KPa.

Sample No.	Cure Period days	Dry Density KN/m^3	Percent Compaction %	Final Moisture Content %	Peak Strength $\sigma_1 - \sigma_3$ KPa	Peak Strength Axial Strain %	Residual Strength $\sigma_1 - \sigma_3$ KPa	Residual Strength Axial Strain %	Initial Tangent Modulus MPa
(1)	(2)	(3)	(4)*	(5)	(6)	(7)	(8)	(9)	(10)
S-224-A	0.00	17.15	96.64	7.82	302.89	2.29	252.34	11.31	59.04
S-224-B	0.00	17.16	96.69	7.58	311.91	2.47	262.97	9.43	57.90
S-206-A	1.00	17.15	96.67	6.40	351.89	1.40	221.08	8.21	75.85
S-209-A	3.00	17.24	97.18	2.82	443.81	1.05	302.72	7.81	132.40
S-210-A	7.00	17.15	96.63	1.99	522.74	0.78	320.70	5.83	173.16
S-204-A	14.46	17.39	98.02	1.28	680.44	0.61	398.93	3.95	209.22
S-202-A	27.83	17.18	96.83	0.84	923.43	0.43	277.34	2.48	262.02
S-217-B	56.00	17.19	96.89	0.61	935.00	0.52	335.14	2.48	300.15

Note: 1 KPa = 0.145 psi; 1 KN/m^3 = 6.36 pcf

* Based on standard Proctor

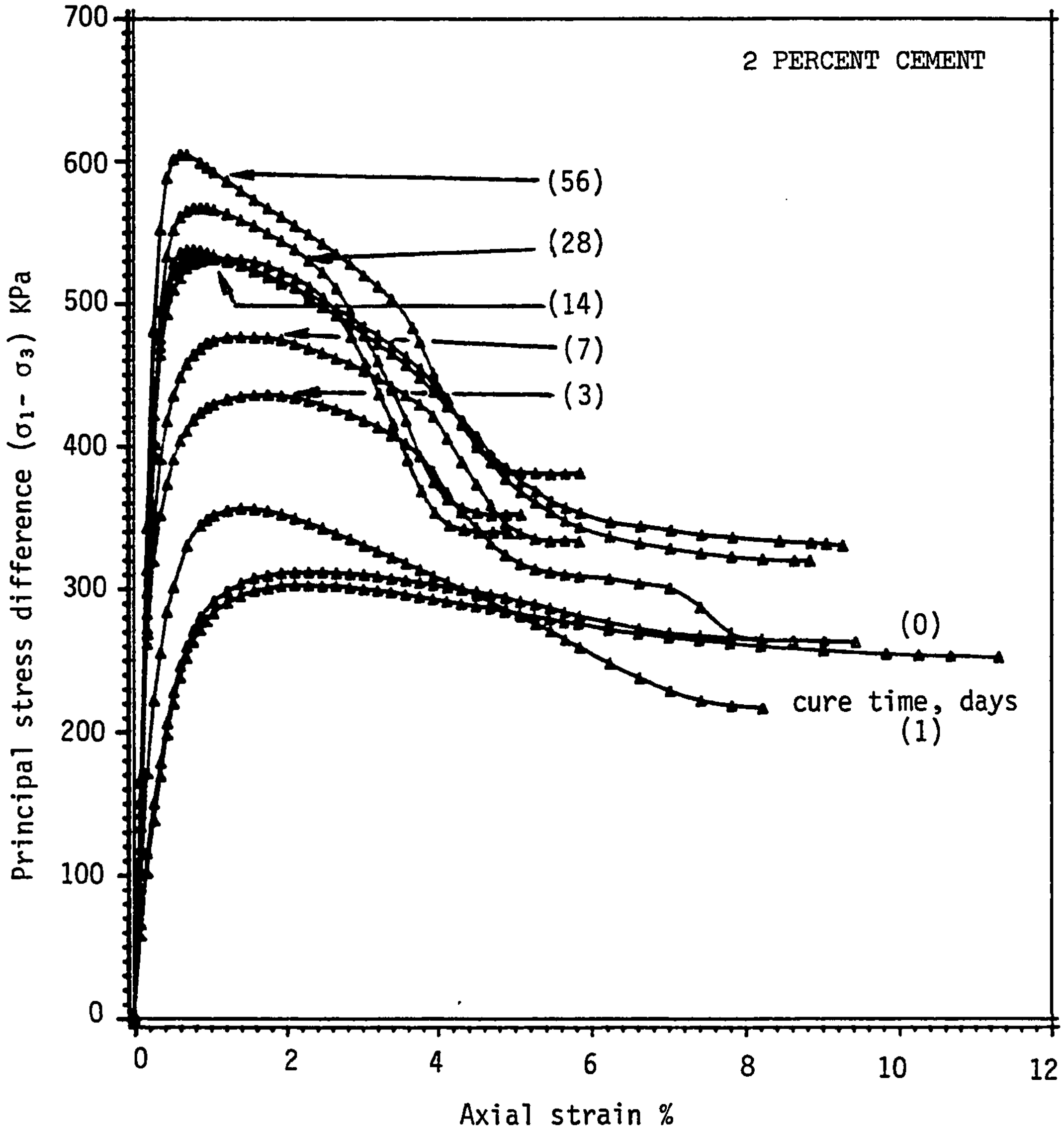


Fig. 4.1: Unsaturated undrained static triaxial stress-strain curves for samples cured in wax for different cure periods and tested at aconfining pressure of 69 KPa.

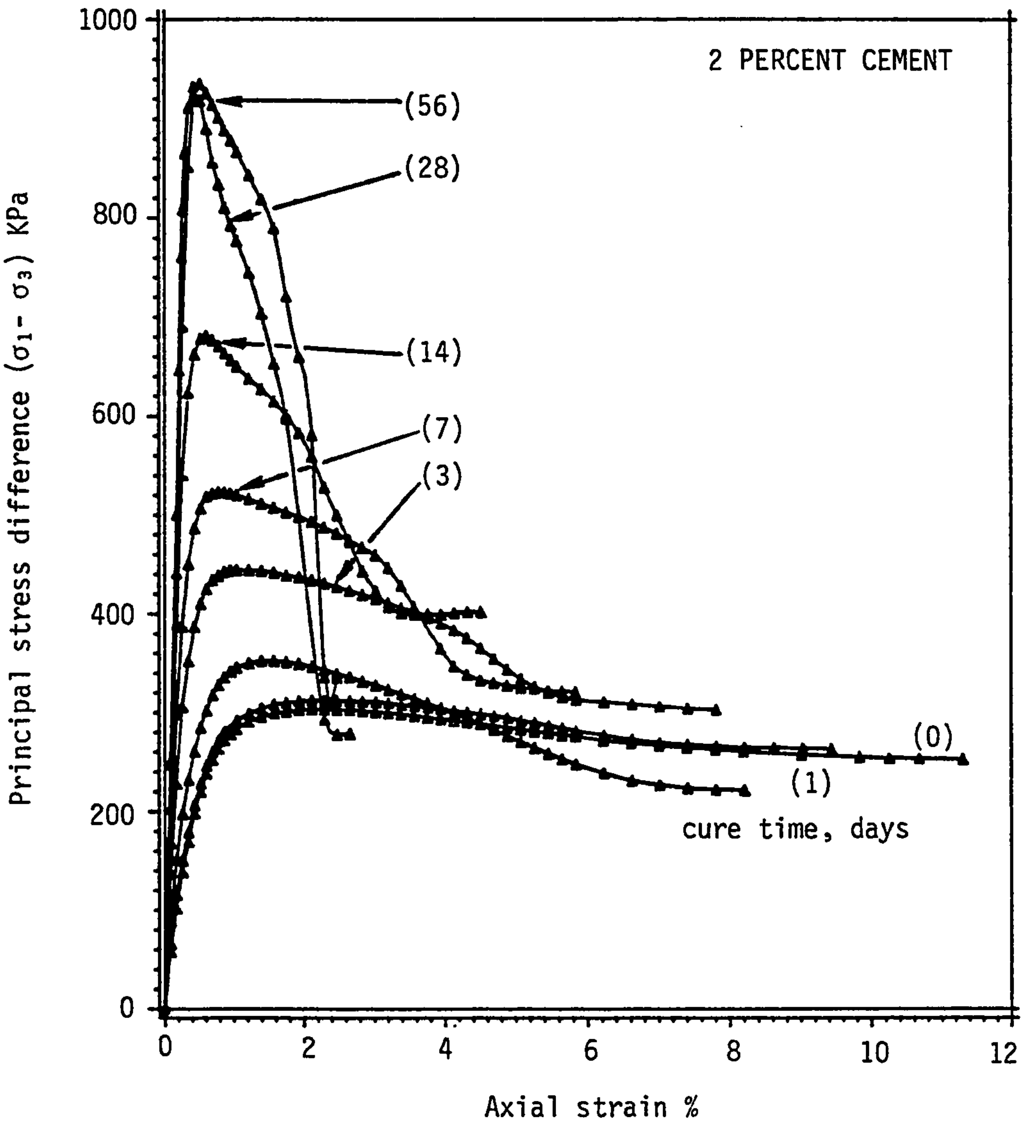


Fig. 4.2: Unsaturated undrained static triaxial stress-strain curves for samples cured out of wax for different cure periods and tested at a confining pressure of 69 KPa.

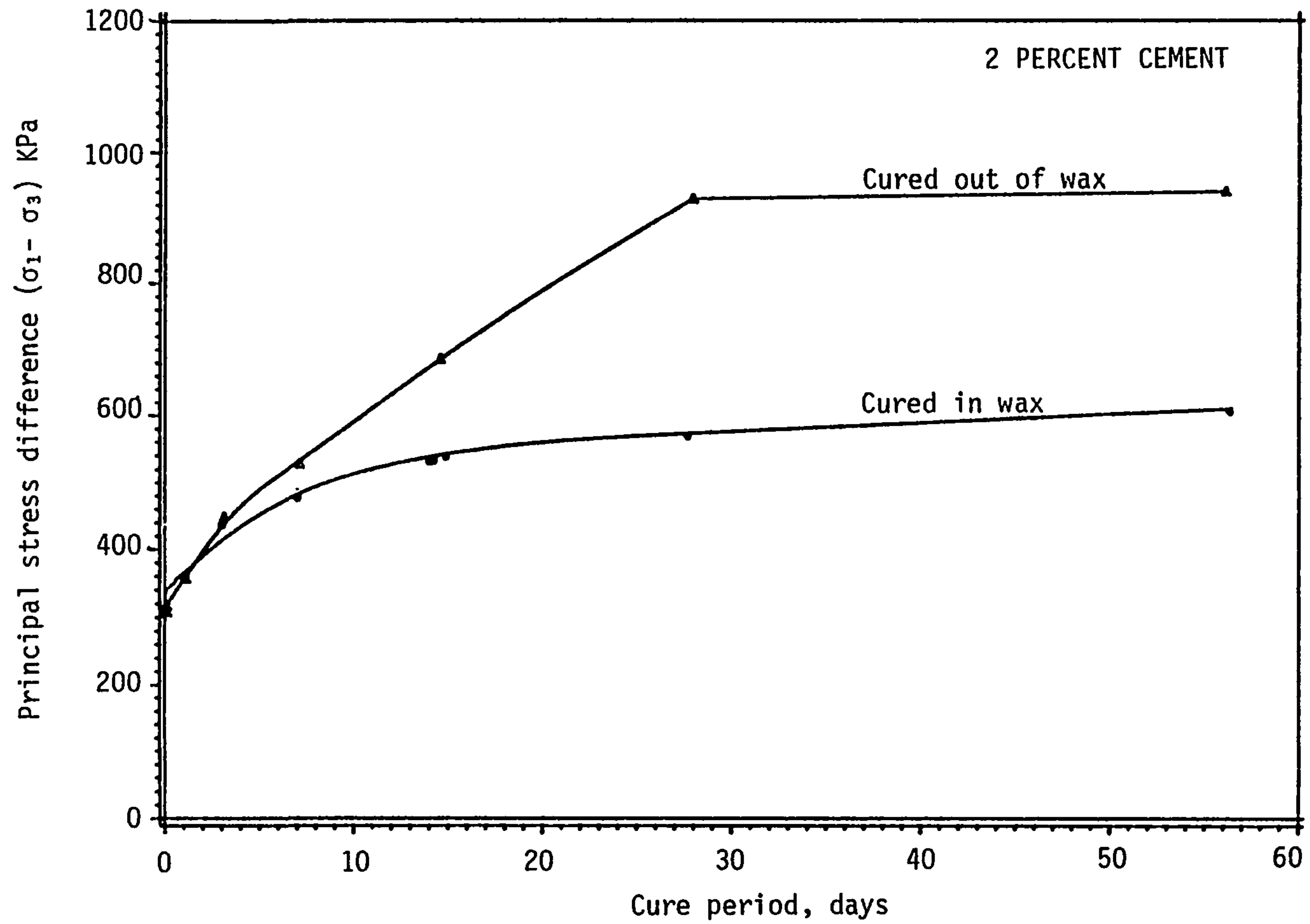


Fig. 4.3: Variation of peak strength with cure period both in wax and out of wax for samples tested at a confining pressure of 69 KPa.

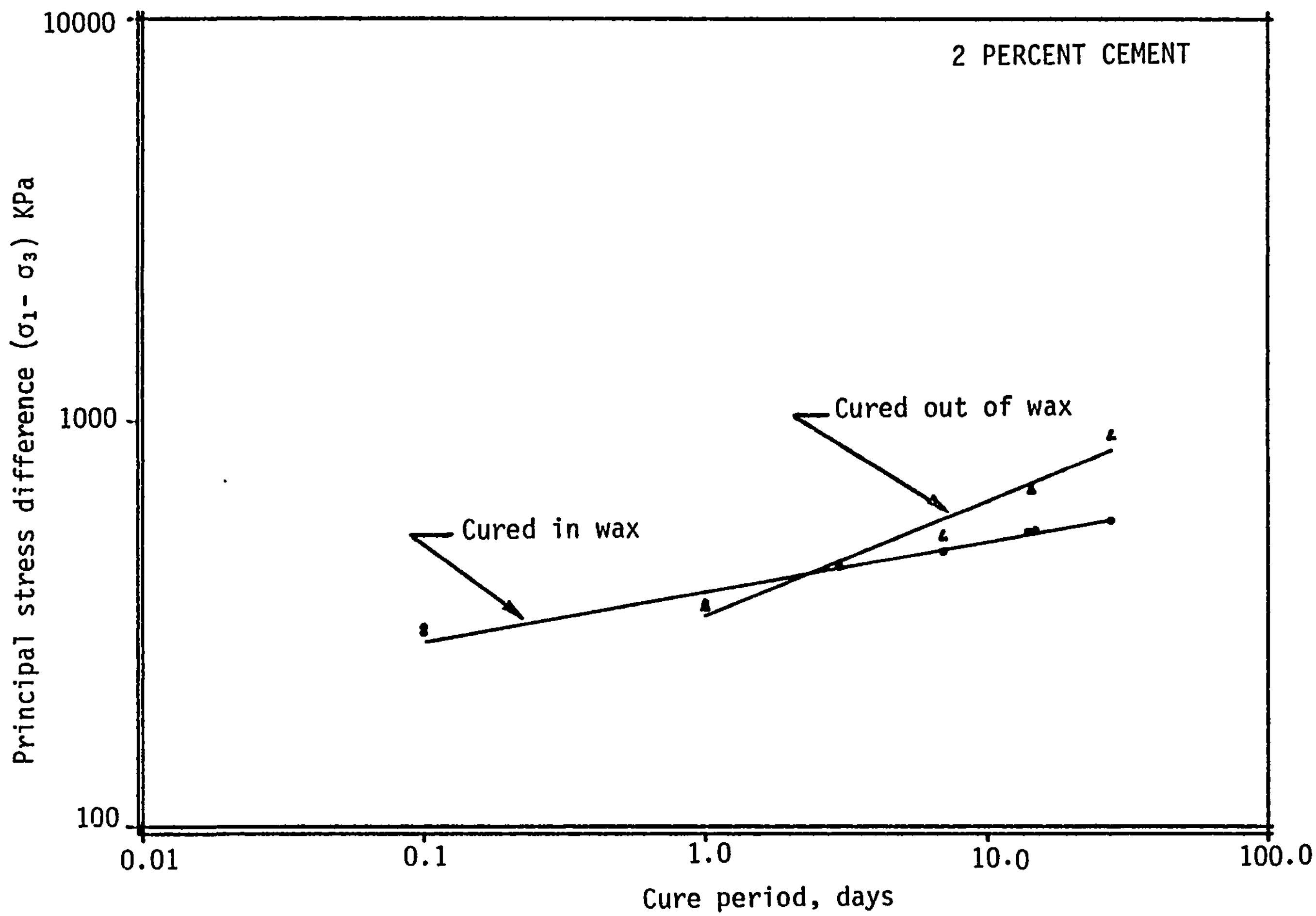


Fig. 4.4: Variation of peak strength with cure period both in wax and out of wax for samples tested at a confining pressure of 69 KPa.

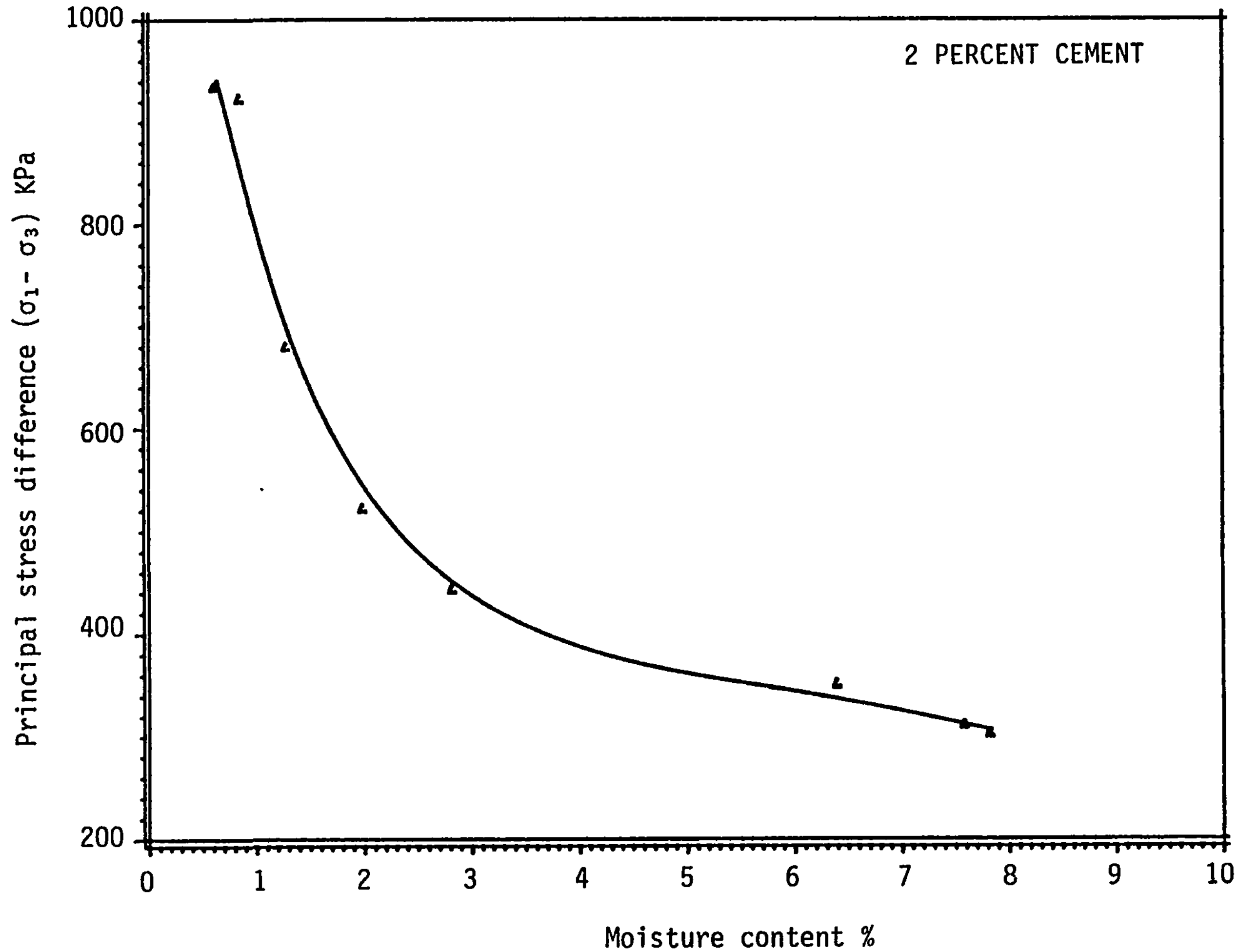


Fig. 4.5: Variation of peak strength with final moisture content for samples cured out of wax for different cure periods and tested at a confining pressure of 69 KPa.

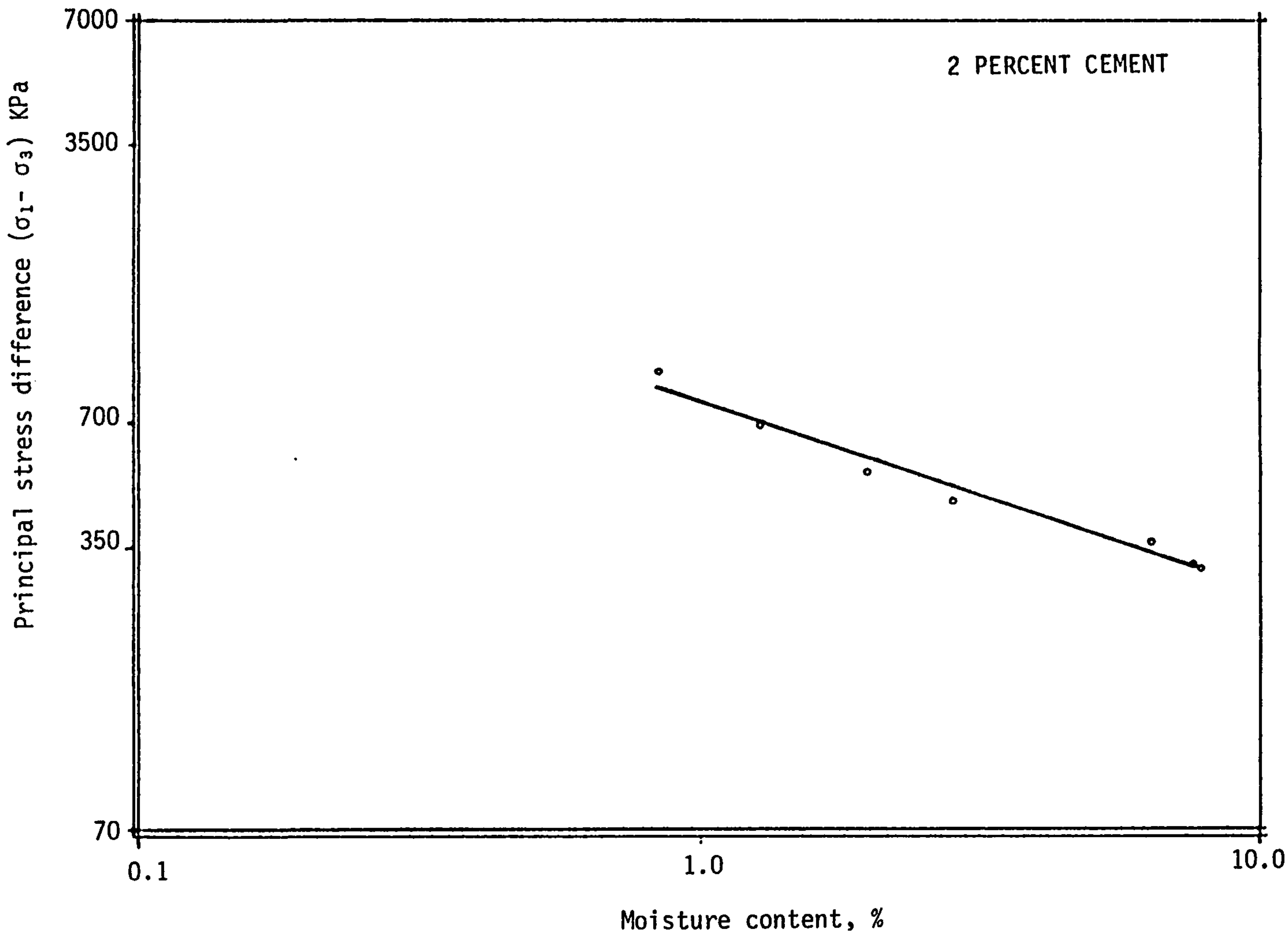


Fig. 4.6: Variation of peak strength with final moisture content for samples cured out of wax for different cure periods and tested at a confining pressure of 69 KPa.

variation of the moisture content at testing time against peak deviatoric stress for samples cured out of wax for varying periods. Samples, cured out of wax and tested at low moisture content, exhibited a brittle failure mode and a unique well defined shear failure surface as shown in plate 4.1. Samples cured in wax and tested at a higher moisture content exhibited a ductile failure mode characterized by the absence of a well defined shear failure surface where more than one potential failure surface may be identified as shown in plate 4.2. The reason for this difference in behavior may be attributed to the contribution of different components responsible for strength. For dry samples, the main contribution comes from the cementation component. Another contribution comes from the surface tension of the water which exist between the grains. On the other hand, the excess water in those samples with higher moisture content softens the specimens and lowers the peak strength values attributable to cementation component. After the specimen has failed, the residual strength is provided primarily by the frictional resistance since the cementation bonds have already been broken. Other contributing factors may also be active in resisting deformation but are difficult to separate individually.

The main difference between samples cured in wax and those cured out of wax is that in the latter, the drying process leads to higher strength values after a few days of cure. Stress-strain curves in Fig. 4.2 show that the peak strength values for samples cured out of wax occur at axial strains less than those for samples cured in wax for the same period (Fig. 4.1). This can be seen clearly in Fig. 4.7

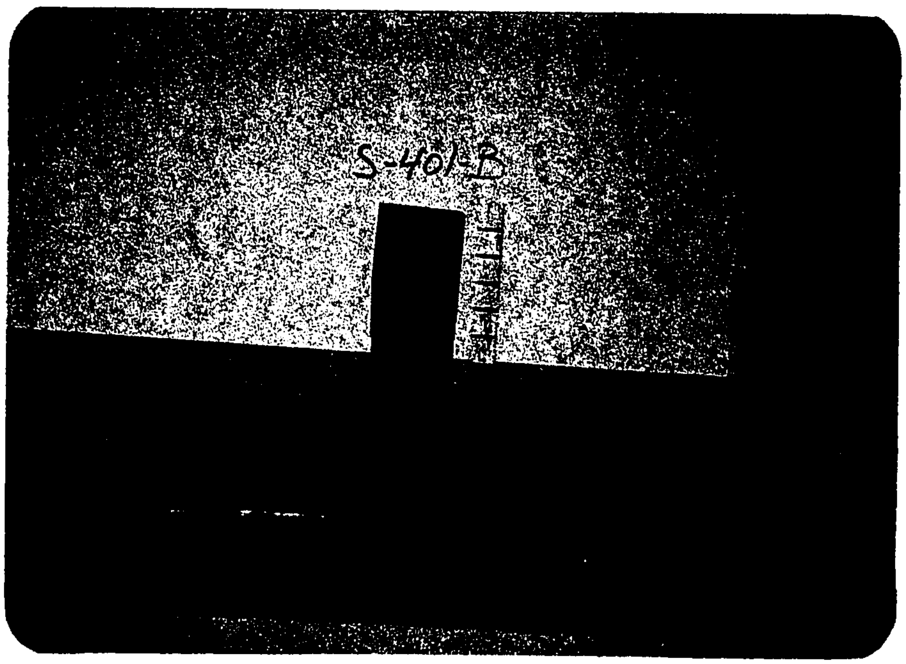
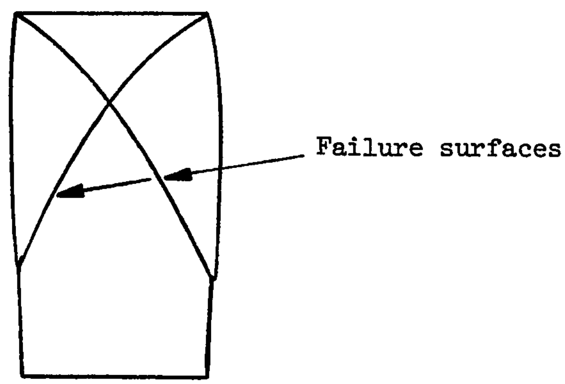
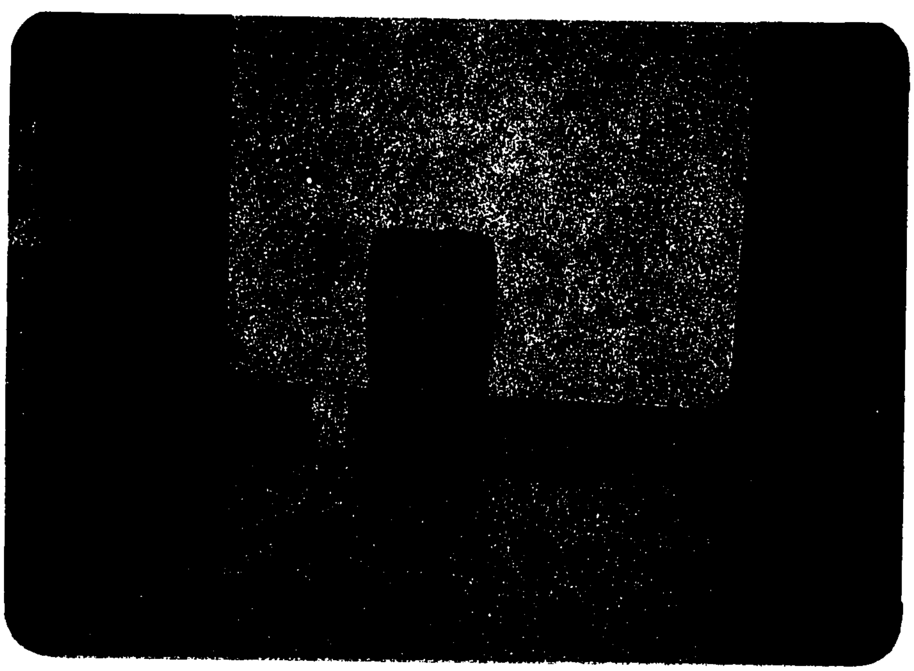


Plate 4.1: Typical failure mode for samples with one potential failure surface.



A



B

Plate 4.2: Typical failure mode for samples with more than one potential failure surface.

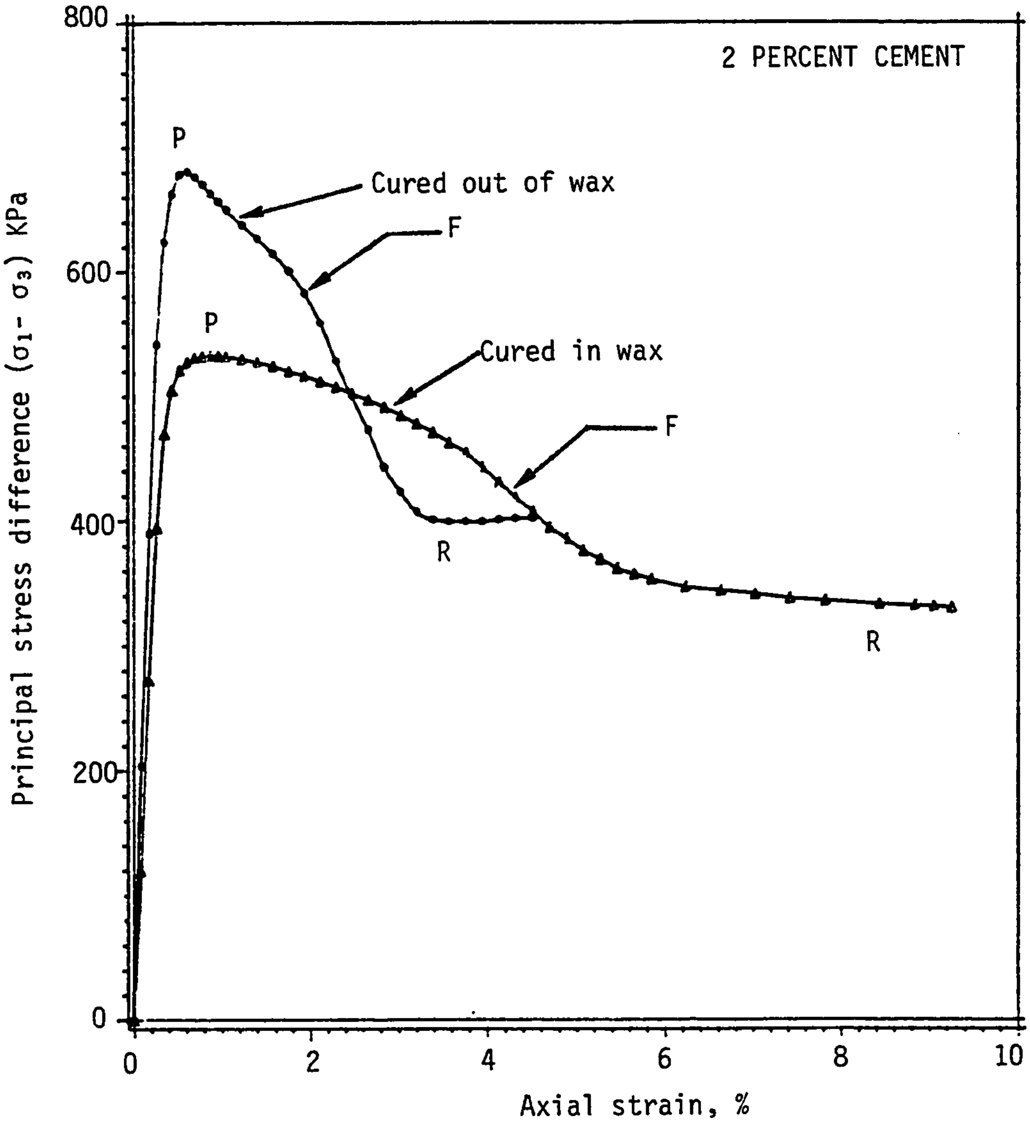


Fig. 4.7: Unsaturated undrained static triaxial stress-strain curves showing two identical samples, one cured in wax and one out of wax for 14 days and tested at a confining pressure of 69 KPa.

where one sample which was cured out of wax for 14 days is compared with one which was cured in wax for the same period. The stress--strain curves can be divided into four segments separated by the points P, F and R. Point P represent the peak value at which the sample reaches its maximum strength. This peak value was reached at relatively low axial strain for both types of samples. The post-peak response (point P to R) is characterized by strain softening which is more pronounced in samples cured out of wax and are accompanied by rapid loss of strength where the failure is considered to be brittle. On the other hand gradual loss of strength, for samples cured in wax, is observed and failure is considered to be somewhat ductile. This ductility of samples with higher moisture content at testing time (cured in wax) is due to the softening effect of the water which may also result in more than one potential failure surface. The post-peak nonlinear behavior is initiated by the yielding of the cement bonds along the failure plane. Point F, an inflection point on the stress--strain curves, represents a change in the resistance mobilized against shear which may correspond to the end of cementation contribution and the start of the frictional stage of resistance. In either types and after point F has been reached, the shear strength appears to drop more rapidly towards its residual value depicted by point R which occurs at relatively higher values of axial strain for samples cured in wax compared to lower values of axial strain for samples cured out of wax.

The high strength in samples cured out of wax is coupled with higher initial tangent modulus values as shown in Fig. 4.8. The

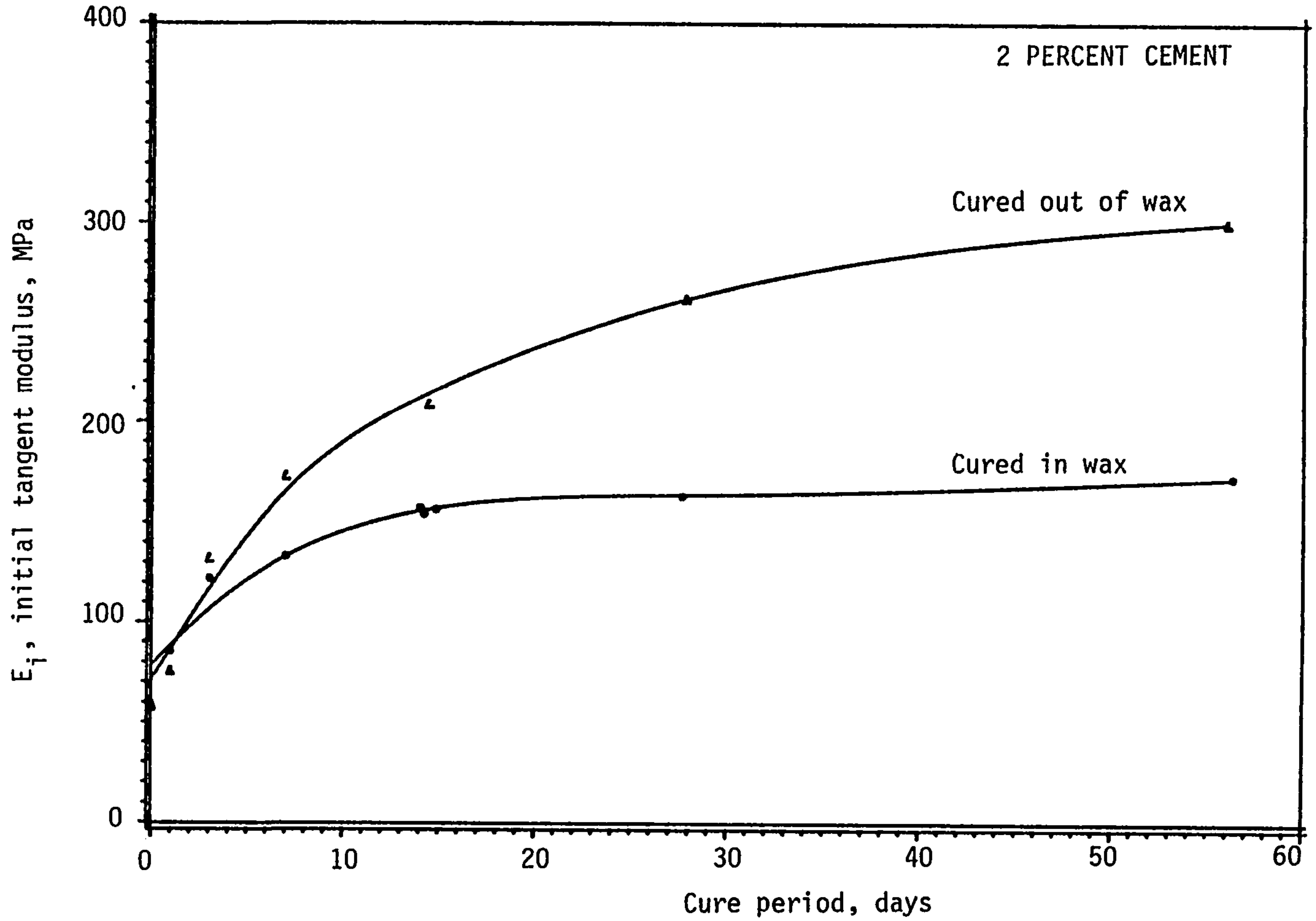


Fig. 4.8: Variation of initial tangent modulus with cure period both in wax and out of wax for samples tested at a confining pressure of 69 KPa.

values of initial tangent modulus were calculated and plotted against cure period in Fig. 4.8 on a natural scale and in Fig. 4.9 on a logarithmic scale for both types of cure, where 0.1 day replaces the zero time and up to 28 days cure period in the logarithmic scale. Figures 4.10 and 4.11 show the initial tangent modulus values against moisture content for all samples cured out of wax.

Residual strength values were determined from the stress--strain data where the curves leveled off after passing through point F. The values of the residual strength appear not to be affected whether a sample is cured in or out of wax except that the stress--strain curves level off early (at low values of axial strain) for samples cured out of wax as compared to higher values of axial strain for those cured in wax for the same cure period.

4.2.2 Effect of cure time

4.2.2.1 Peak Strength

Portland cement hydration requires time, the longer the cure time the more hydration will take place and the higher the strength gained, but up to a certain limit after which no more hydration and no more increase in strength will take place. This limit depends on a number of factors including percent cement and cure conditions. Unsaturated undrained triaxial test results of cemented sand samples are shown in table 4.1 for samples cured in wax and in table 4.2 for samples cured out of wax. Peak strength values increase with cure

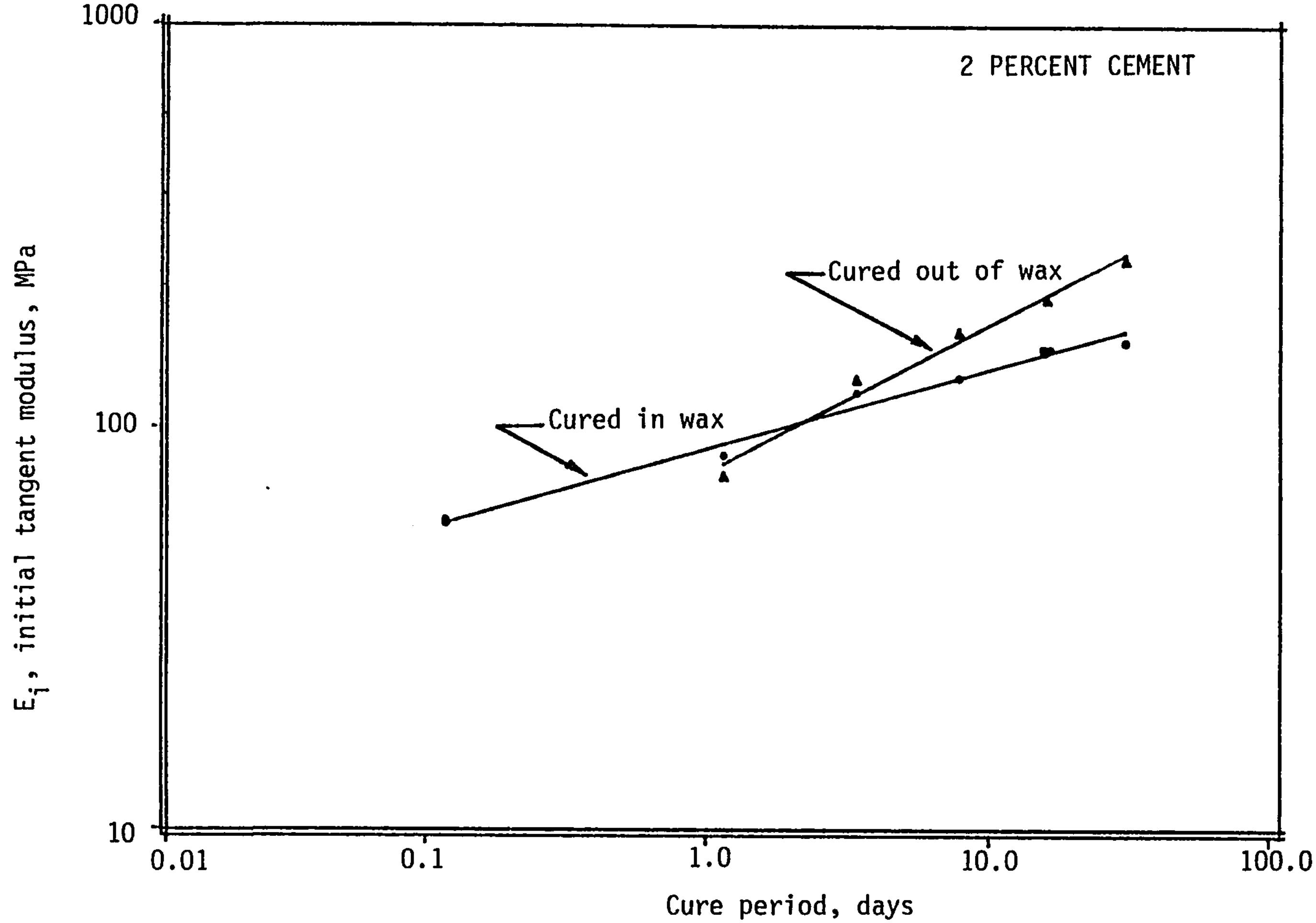


Fig. 4.9: Variation of initial tangent modulus with cure period both in wax and out of wax for samples tested at a confining pressure of 69 KPa.

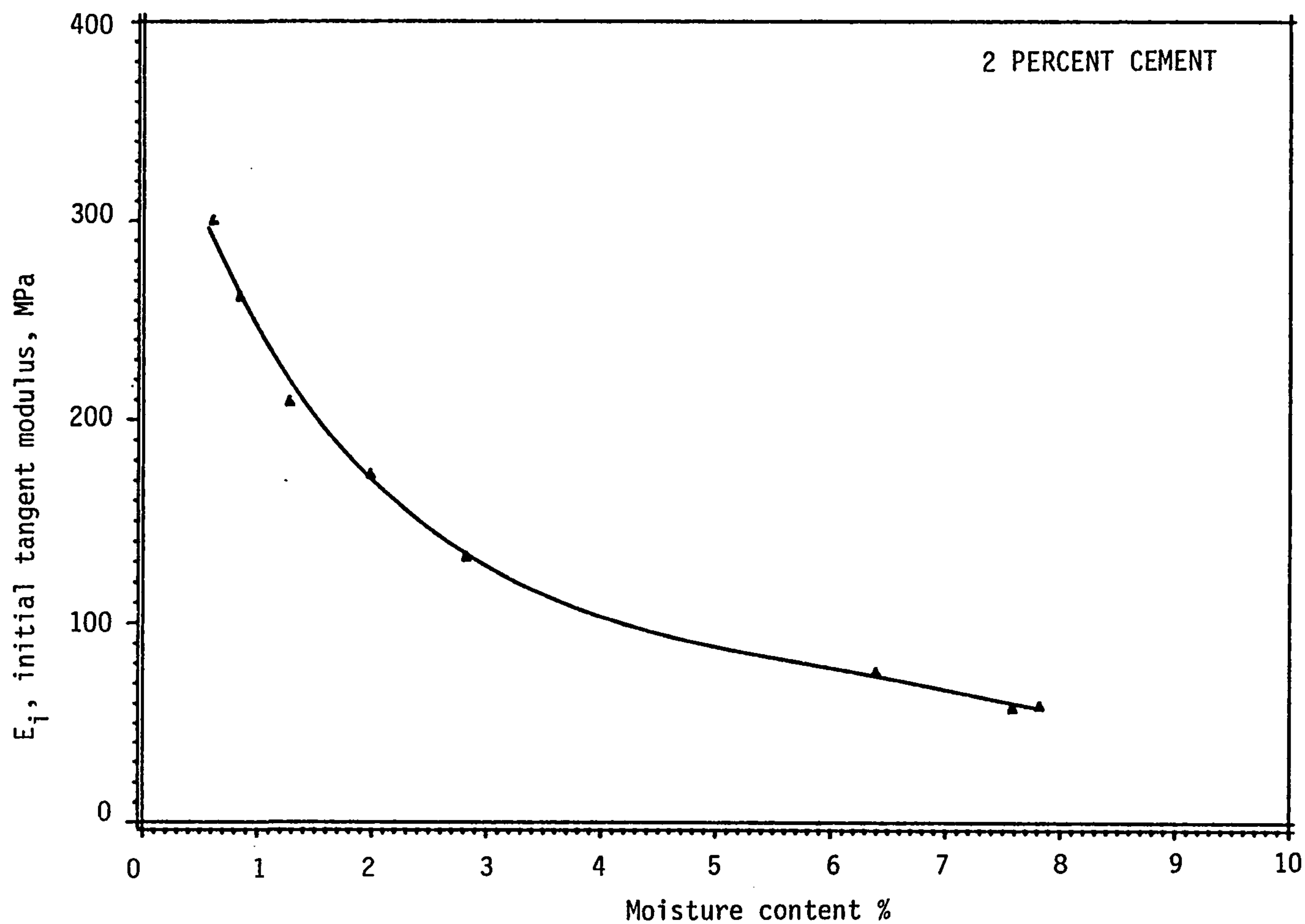


Fig. 4.10: Variation of initial tangent modulus with final moisture content for samples cured out of wax for different cure periods and tested at a confining pressure of 69 KPa.

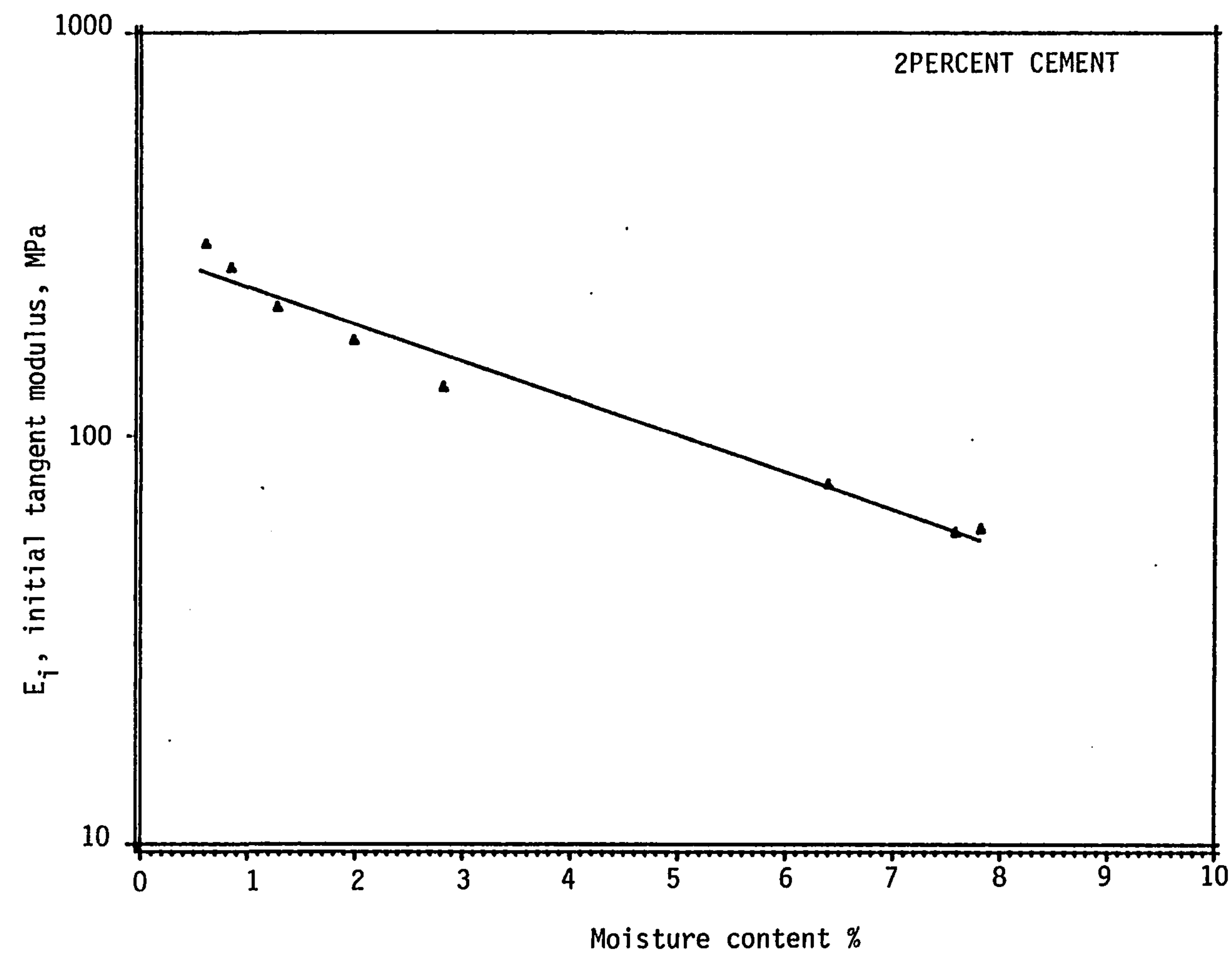


Fig. 4.11: Variation of initial tangent modulus with final moisture content for samples cured out of wax for different cure periods and tested at a confining pressure of 69 KPa.

period as shown in Fig. 4.3 on a natural scale. Figure 4.4 show the same data on a log-log scale with a straight line fit. The fast hydration takes place during early cure periods where the gain in peak strength is relatively high. Beyond 28 days of cure the gain in peak strength is relatively low because most of the cement has hydrated already (see Fig. 4.3).

In samples cured out of wax, the faster rate of hydration in the early cure periods was accompanied by the drying process and thus the gain in peak strength is higher than those samples cured in wax for the same period. This gain in strength with increasing cure time coupled with decreasing moisture content is due principally to hydration of portland cement with time. Additionally, surface tension (which tends to increase as moisture content decreases) may also be contributing partly to increased strength.

4.2.2.2 Deformation Modulus Values

Initial tangent modulus values increase with increasing cure period as shown in Fig 4.8. The gain in modulus values with time is due to the fact that the peak strength values occur at relatively higher axial strains at early cure periods, and at relatively lower axial strain values at longer cure periods. This results in higher E_i values as the samples cure for longer periods. Increased strength is normally coupled with increased E_i. Specimens cured out of wax exhibit higher E_i values than those cured in wax for the same period. This additional increase in the E_i values as a function of time may be attributed to the gradual drying process that causes a gradual increase in surface tension, and thus a gain in strength and modulus value.

4.2.2.3 Residual Strength Values

The residual strength of each specimen was determined from the stress-strain data where the curves leveled off following the peak in the curve. These residual strength values once reached do not undergo any noticeable change as the sample continues to strain (see Figures 4.1 and 4.2).

4.2.3 Effect of Confining pressure

The confining pressure (minor principal stress) was varied for specimens with 2% cement and cured in wax for 14 days. Samples were tested under a 69, 138, 207 and 276 KPa (10, 20, 30 and 40 psi) confining pressure in unsaturated undrained condition, as well as in a drained static triaxial mode. All other variables were kept constant. The results of the unsaturated undrained tests are shown in Table 4.3. The drained tests results are shown in Table 4.4. The resulting stress-strain diagrams are shown in Fig. 4.12 for the unsaturated undrained tests, and in Fig. 4.13 for the drained tests along with the volumetric change data shown directly below the stress strain curves.

Table 4.3: Results of Unsaturated Undrained Static Triaxial Tests of Cemented Sand Samples with 2% Portland Cement, Cured in Wax for 14 Days and Tested at Different Confining Pressures.

Sample No.	Confining Pressure KPa	Dry Density KN/m^3	Percent Compaction %	Final Moisture Content %	Peak Strength $\sigma_1 - \sigma_3$ KPa	Peak Strength Axial Strain %	Peak Strength q KPa	Peak Strength p KPa	Residual Strength $\sigma_1 - \sigma_3$ KPa	Residual Strength Axial Strain %	Residual Strength q KPa	Residual Strength p KPa	Initial Tangent Modules MPa
(1)	(2)	(3)	(4)*	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
S-211-A	69	17.16	96.70	7.34	531.97	1.23	265.98	334.98	339.18	4.92	169.59	238.59	157.40
S-219-B	69	17.19	96.88	7.31	532.35	0.87	266.18	335.18	330.31	9.26	165.16	234.16	154.40
S-227-A	69	17.14	96.61	7.28	537.70	0.78	268.85	337.85	319.58	8.83	159.79	228.79	159.59
S-212-A	138	17.13	96.55	7.48	814.60	1.40	407.30	545.30	553.33	8.83	276.67	414.67	175.11
S-215-A	207	17.22	97.07	7.40	1064.41	1.93	532.20	739.20	775.61	11.12	387.80	594.80	184.58
S-214-A	276	17.17	96.73	7.27	1332.92	1.94	666.46	942.46	1016.93	9.87	508.47	784.47	195.39

Note: 1 KPa = 0.145 psi; 1 KN/m^3 = 6.36 pcf

* Based on standard Proctor

Table 4.4: Results of Drained Static Triaxial Tests of Cemented samples with 2% Portland Cement, Cured in Wax for 14 Days and Tested at Different Confining Pressures.

Sample No.	Confining Pressure KPa	Dry Density KN/m^3	Percent Compaction %	Final Moisture Content %	Degree of Saturation %	Peak Strength				
						$\sigma_1 - \sigma_3$ KPa	Axial Strain %	Volumetric Strain %	q KPa	p KPa
(1)	(2)	(3)	(4)*	(5)	(6)	(7)	(8)	(9)	(10)	(11)
S-213-A	69	17.17	96.80	20.60	97.12	482.23	0.61	0.21	241.11	310.11
S-227-B	69	17.26	97.32	20.80	100.00	462.47	0.78	0.38	231.24	300.24
S-216-B	138	17.11	96.44	20.71	99.47	744.63	0.96	0.35	372.32	510.32
S-219-A	207	17.22	97.06	20.51	100.00	1036.55	1.05	0.20	518.17	725.17
S-214-B	276	17.13	96.55	20.91	99.74	1328.44	1.40	0.31	664.22	940.22

Note: 1 KPa = 0.145 psi; 1 KN/m^3 = 6.36 pcf

* Based on standard Proctor

Table 4.4 (Cont'd)

Sample No.	Confining Pressure KPa	Residual Strength $\sigma_1 - \sigma_3$ KPa (12)	Axial Strain % (13)	Volumetric Strain % (14)	q KPa (15)	p KPa (16)	Initial Tangent Modulus MPa (17)
S-213-A	69	242.04	4.14	3.07	121.02	190.02	144.90
S-227-B	69	241.35	3.95	3.32	120.67	189.67	131.85
S-216-B	138	481.90	5.67	3.06	240.95	378.95	167.93
S-219-A	207	675.20	6.82	2.97	337.60	544.60	185.40
S-214-B	276	859.91	9.46	2.80	429.96	705.96	198.13

Note: 1 KPa = 0.145 psi; 1 KN/m^3 = 6.36 pcf

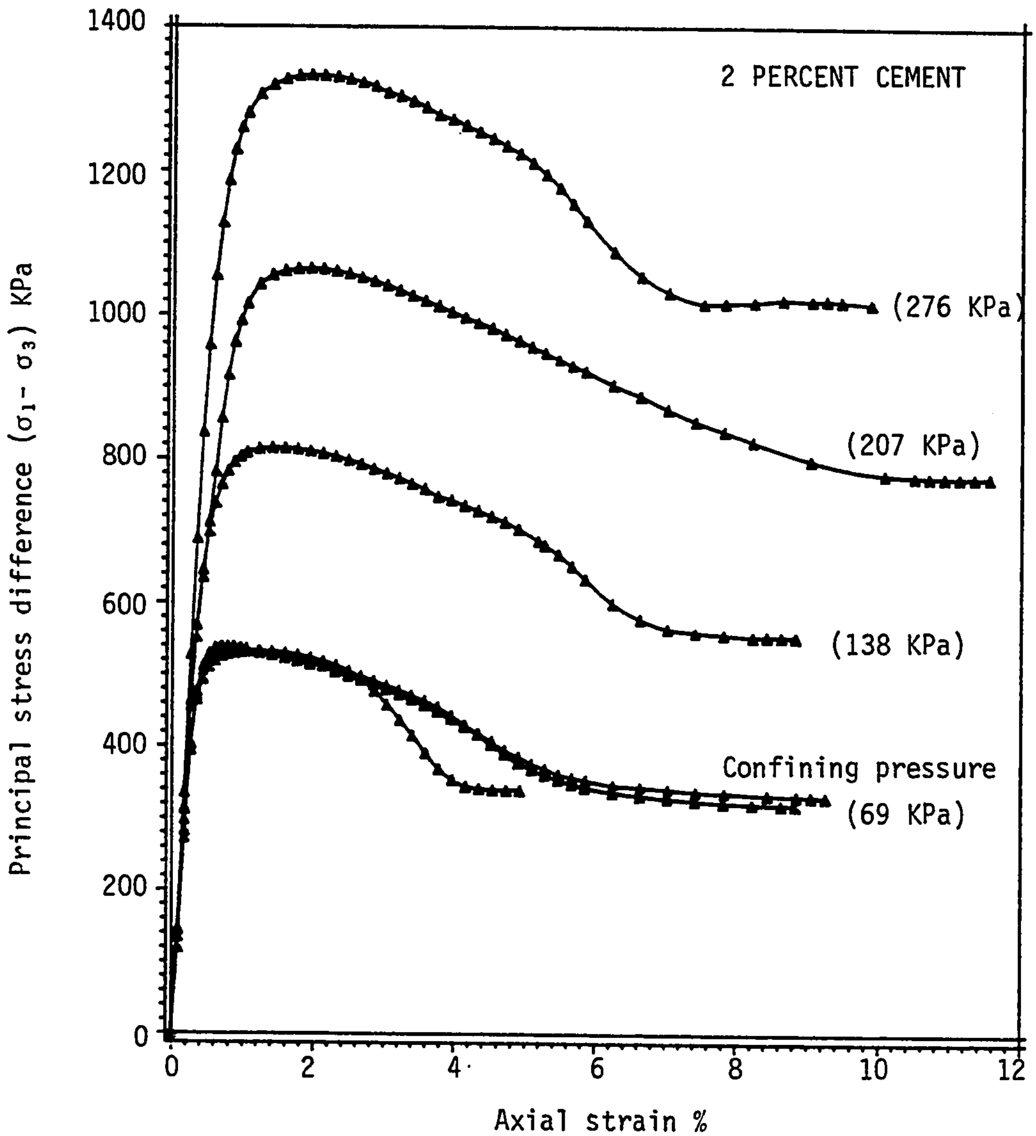


Fig. 4.12: Unsaturated undrained static triaxial stress-strain curves for samples cured in wax for 14 days and tested at different confining pressures.

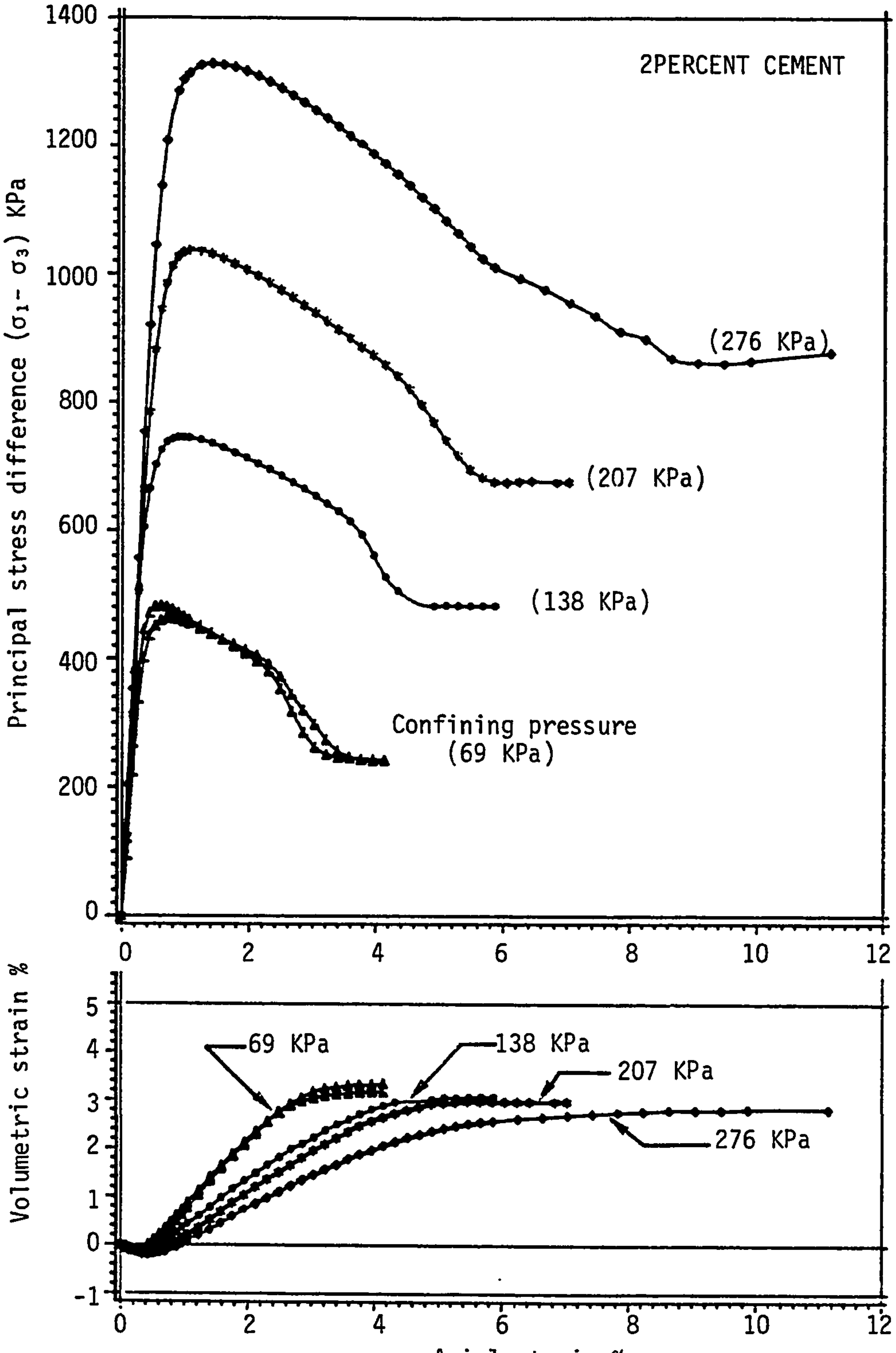


Fig. 4.13: Drained static triaxial stress-strain curves for samples cured in wax for 14 days and tested at different confining pressures.

4.2.3.1 Peak strength values

Peak strength values increase with confining pressure whether tested in unsaturated undrained condition or drained condition. The maximum principal stress difference values are plotted against the confining pressure for both drained and as molded tests in Fig. 4.14. Linear relationship between strength and confining pressure may be assumed as shown in Fig. 4.14.

At low confining pressure, the unsaturated undrained tests result in higher peak strength values than those in drained tests. However as the confining pressure increases the difference diminishs and they become almost equal at a confinement of about 276 KPa (40 psi).

The peak strength envelopes, or what is known as the p-q diagrams, were drawn in lieu of Mohr diagrams so that failure conditions can be represented by points rather than by Mohr circles. The p-q diagrams for the unsaturated undrained as well as the drained tests are plotted in Fig 4.15. The cohesion and angle of internal friction were calculated [21] from equation 4.1 which represents the straight line shown in Fig. 4.16 where:

$$q_f = \frac{\sigma_1 - \sigma_3}{2} \qquad p_f = \frac{\sigma_1 + \sigma_3}{2}$$

and

$$q_f = a + P_f \tan\alpha$$

$$\sin\phi = \tan\alpha$$

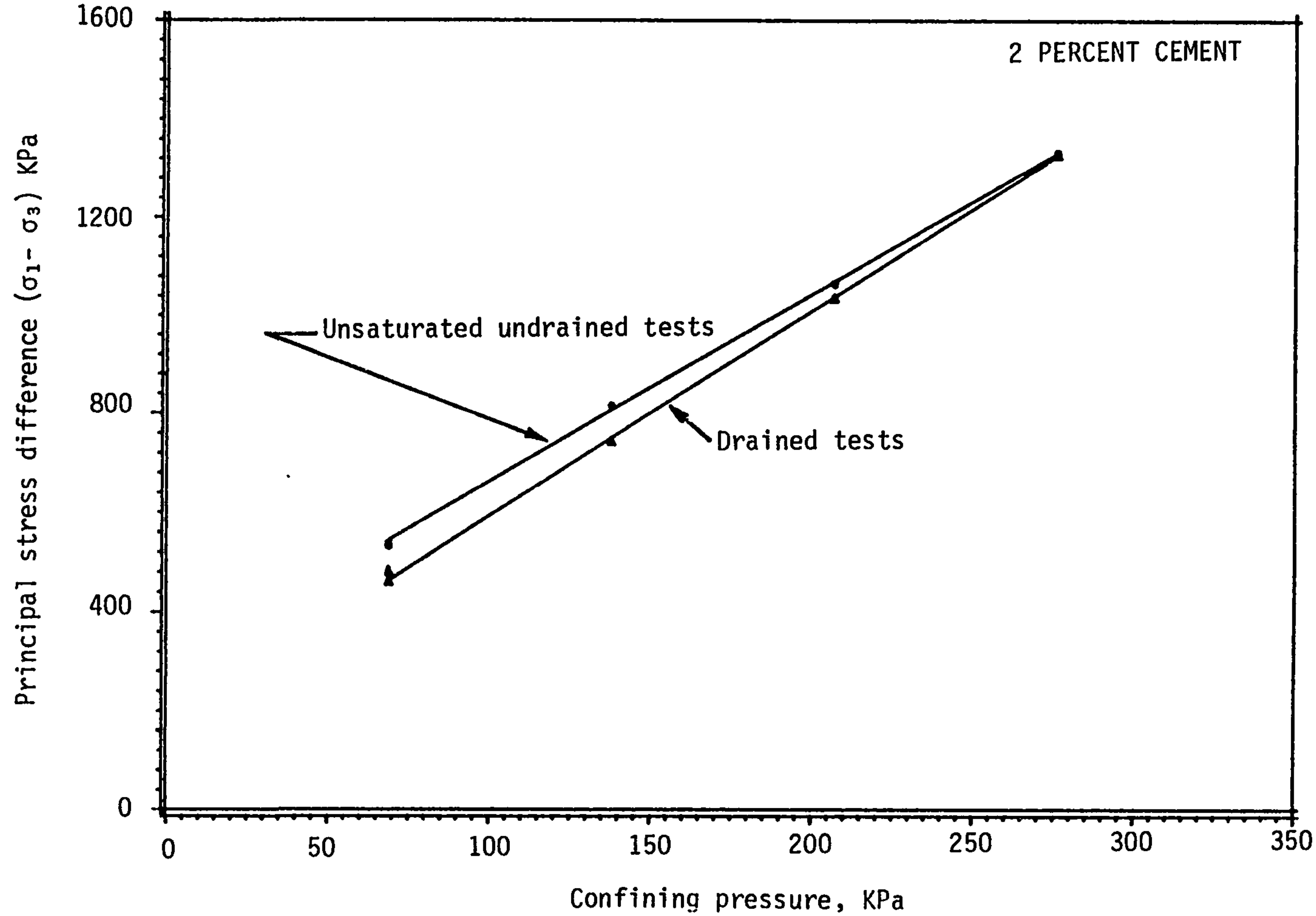


Fig. 4.14: Variation of peak strength with confining pressure for samples cured in wax for 14 days.

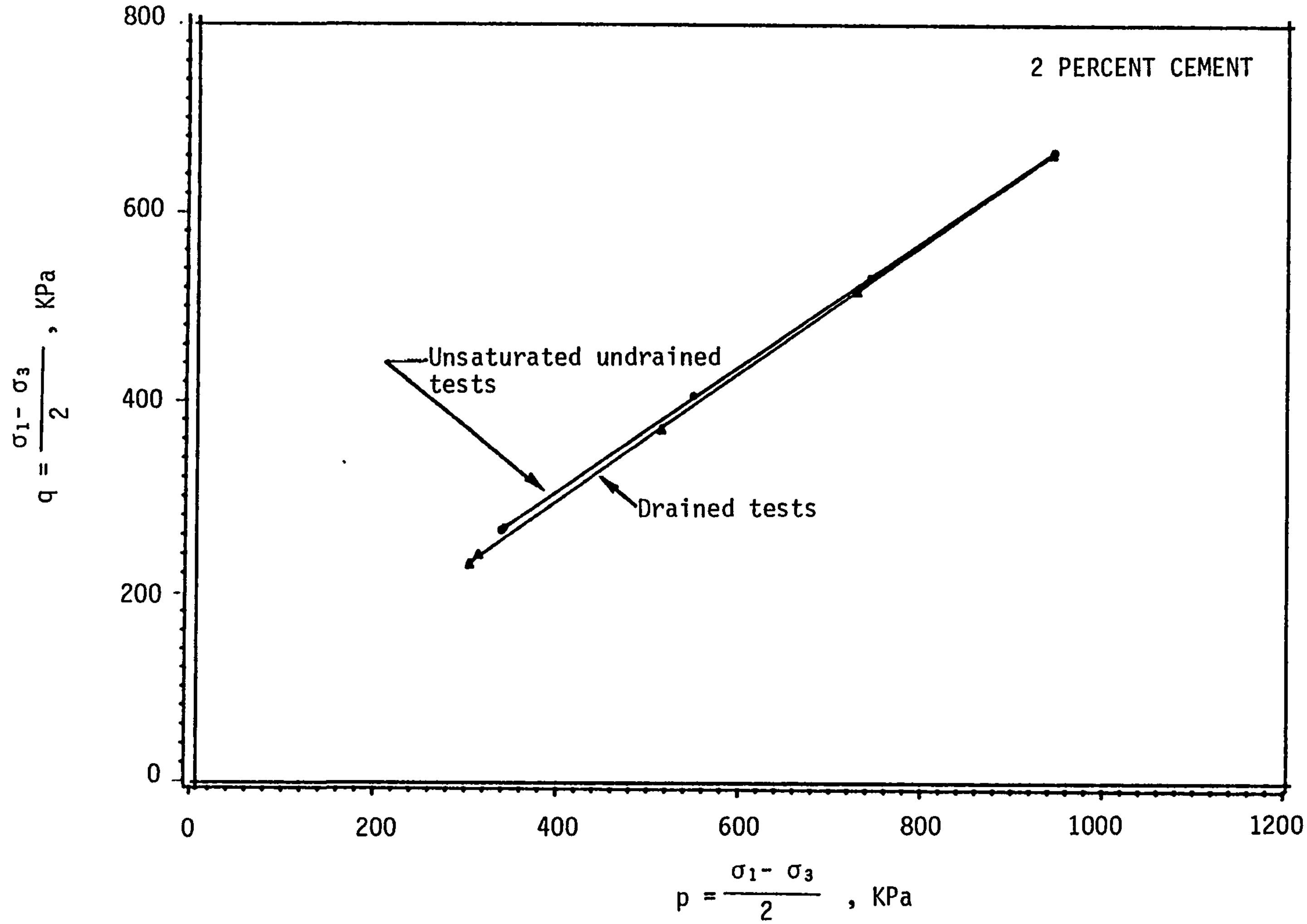


Fig. 4.15: p-q diagram based on peak strength values for samples cured in wax for 14 days and tested at different confining pressures.

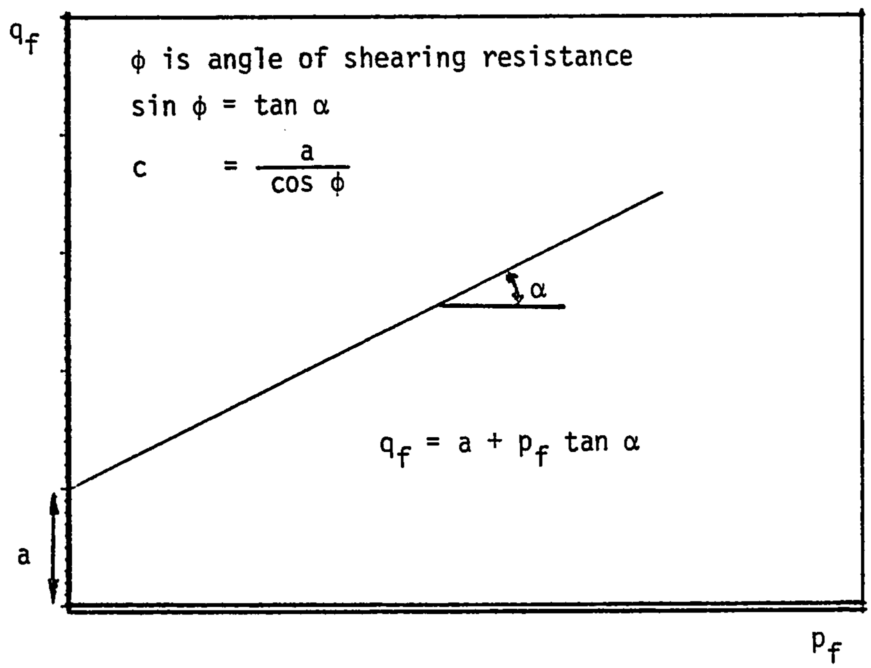


Fig. 4.16: Relation of q_f and p_f to Mohr-Coulomb envelope [21].

$$c = \frac{a}{\cos \phi} \tag{4.1}$$

which results in a cohesion value and angle of internal friction equal to 61.34 KPa and 41.20° for the unsaturated undrained tests, and 40.50 KPa and 42.38° for the drained tests.

4.2.3.2 Residual strength values

According to test results shown in Figures 4.12 and 4.13, residual strength increases with confining pressure. As the confinement increases the residual principal stress difference increases as shown in Fig. 4.17. Residual strength values for the unsaturated undrained tests are higher than those of the drained tests at low as well as high confining pressure levels, but obviously low in both tests compared to the peak values. This is due to the fact that after sample's failure occurs, the contribution due to cementation is not available for either type of samples.

p-q diagrams for residual strength were drawn in Fig. 4.18. The cohesion intercept as well as the angle of internal friction were found using equation 4.1. The cohesion of the unsaturated undrained tests was 24.29 KPa and the angle of internal friction was 38.52°; while the cohesion and angle of friction for the drained test were found to be 9.04 KPa and 37.32° respectively.

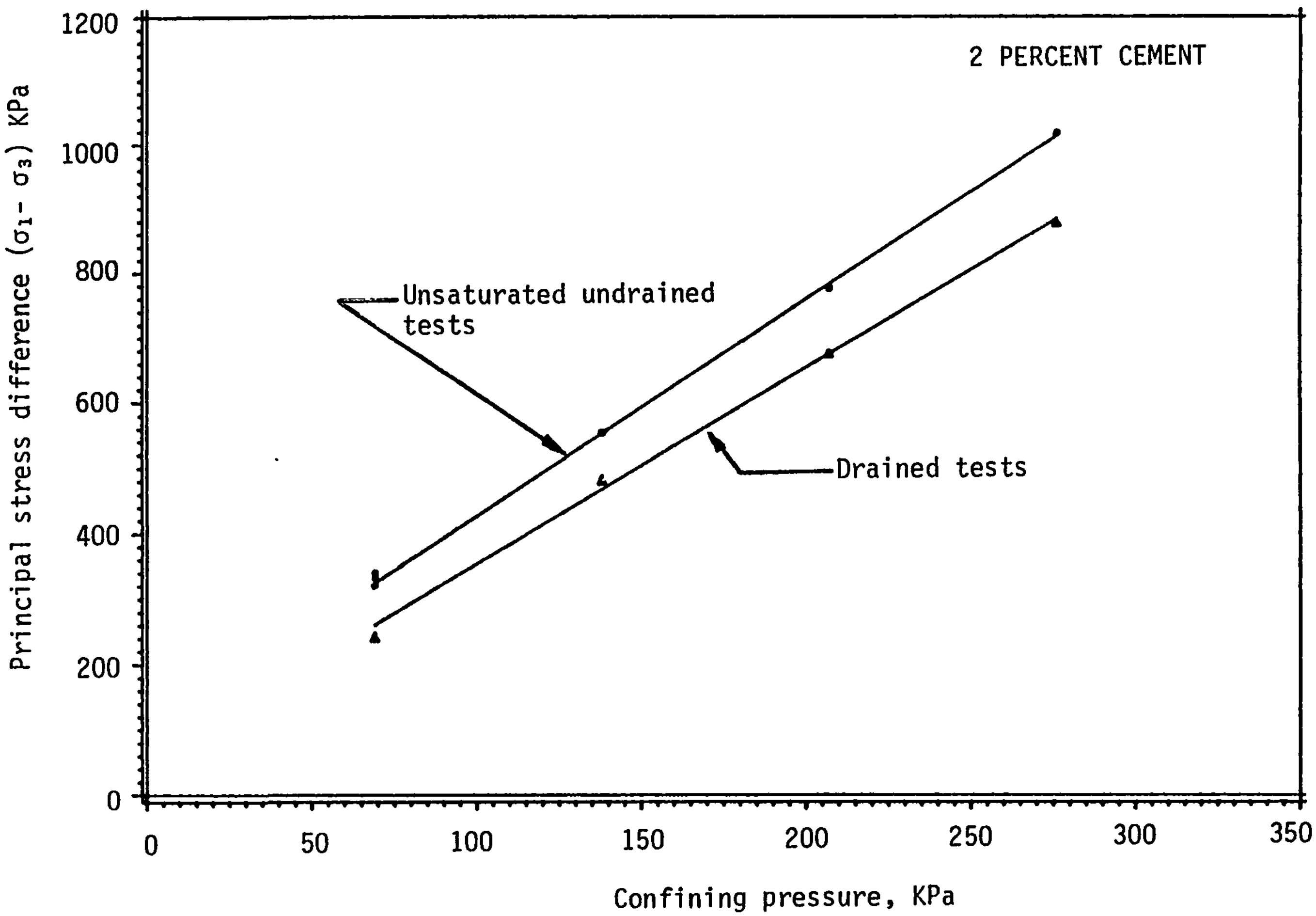


Fig. 4.17: Variation of residual strength with confining pressure for samples cured in wax for 14 days.

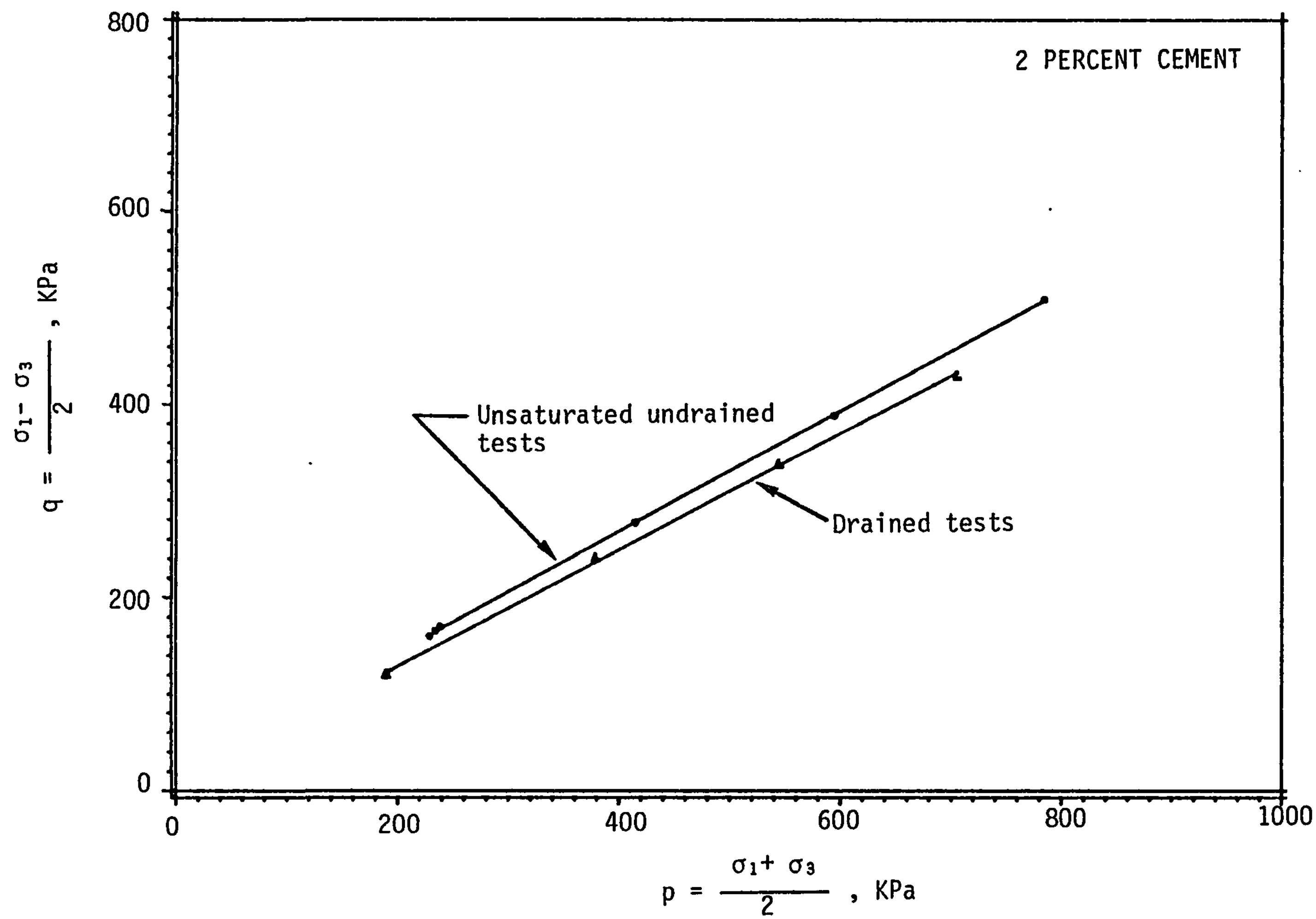


Fig. 4.18: p-q diagram based on residual strength values for samples cured in wax for 14 days and tested at different confining pressures.

5.1.3.3 Deformation Modulus Values

Initial tangent modulus values were obtained and plotted in Fig. 4.19 as a function of the confinement for both drained and unsaturated undrained conditions. The E_i values as well as the confining pressure were normalized by dividing their values by the atmospheric pressure (101.32 KPa). Straight lines can be fitted to the data on the graph of Fig. 4.18 using the equation:

$$E_i = K * P_a \left(\frac{\sigma_3}{P_a}\right)^n \tag{4.2}$$

in which P_a is atmospheric pressure, σ_3 is the confining stress, K is the intercept of the line at $\sigma_3 / P_a = 1.0$ and n is the slope of the line [10, 25, 36]. For cemented sand with 2% portland cement, the value of n is 0.159 and K is 1637.09 in the unsaturated undrained conditions while n is 0.260 and K is 1514.0 in the drained conditions. These values are well within the range given by Mitchell (1976), where he stated that for cement treated soils it appears that K is in the range of 1000 to 10000 and n varies from 0.1 to 0.5 [10, 25, 36].

4.2.3.4 Volumetric Change

Volumetric strains were measured during all drained triaxial tests. During shear and before failure, all test specimens exhibited a decrease in volume. This decrement in volume did not exceed 0.2% of the initial volume. Beyond this point the volume began to increase as the sample continued to shear. The increase in volume for specimens

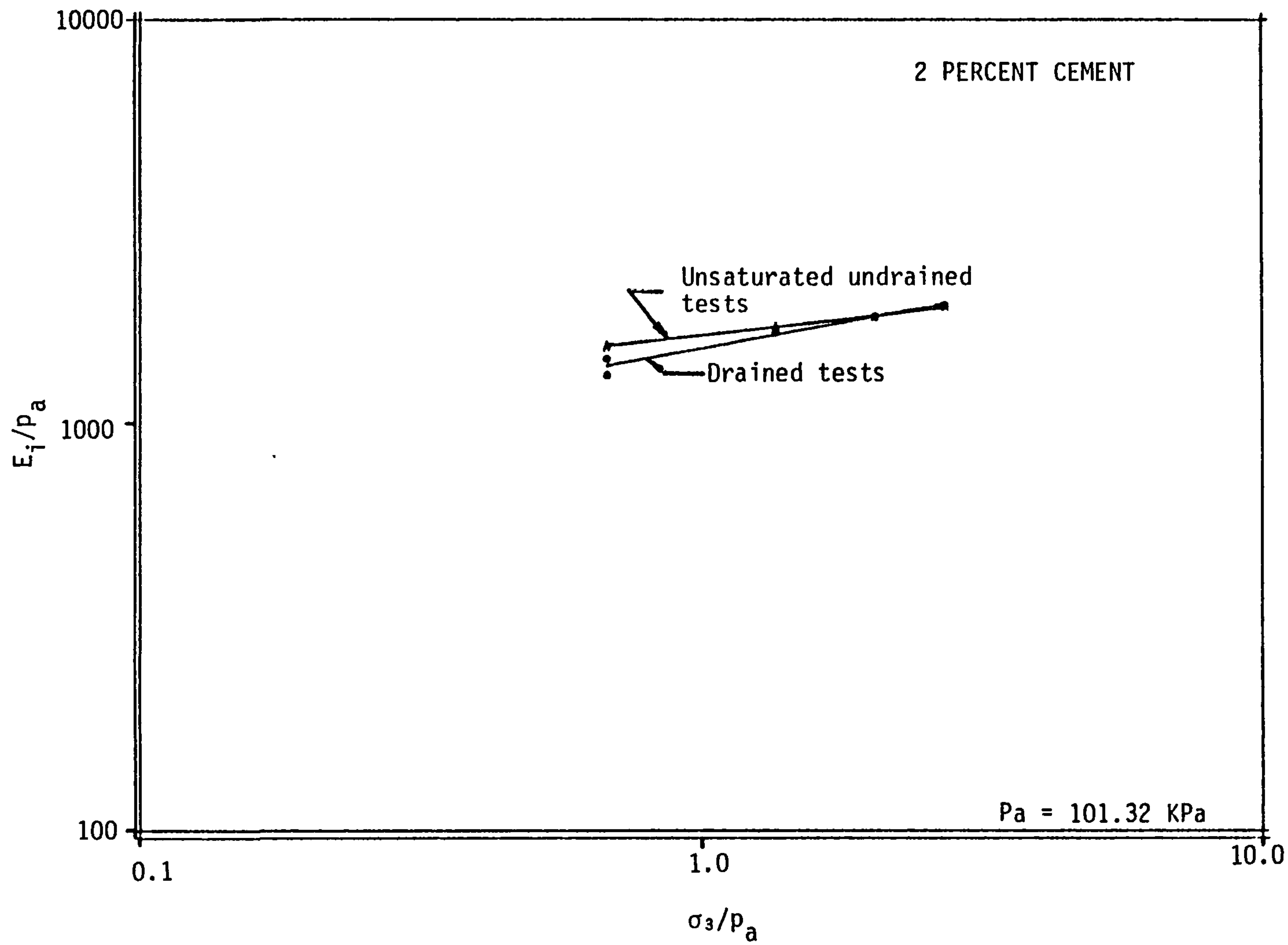


Fig. 4.19: Variation of initial tangent modulus with confining pressure for samples cured in wax for 14 days.

tested at relatively low confining pressure was higher than those tested at higher confinement as shown in Fig. 4.13. It was also noticed that the volume of a specimen kept increasing as long as the deviatoric stress kept decreasing; and when the residual value of deviatoric stress was reached, so did the volumetric strain irrespective of the level of confinement. The residual volumetric strain reached at all confining pressures was about 3%. Samples behaved differently in terms of the value of axial strain reached at which this residual value occurs. This is not consistent with the work done by Clough et al. [8] and Sitar [36]. In their tests, different levels of volumetric strain were reached depending on the level of confinement. This may be due to the fact that samples used in our study were saturated to more than 97% while the degree of saturation for Sitar's [36] specimens was not nearly as high since he did not apply back pressure nor did he add water to specimens.

4.2.4 Effect of Saturation

The effect of saturation on originally wet samples (cured in wax) was not significant. However, the effect of saturation on samples cemented with 2% portland cement and allowed to cure out of wax, and therefore had little moisture left in them, was great and seems to be of interest. Those samples that were allowed to cure out of wax for 7, 14 and 28 days lost most of their moisture and became dry. Saturation of these samples was insured as discussed earlier and drained static triaxial tests were performed with volumetric change measurements. Test results are shown in table 4.5. Stress-strain and

Table 4.5: Results of Drained Static Triaxial Tests of Cemented Sand Samples with 2% Portland Cement, Cured out of Wax for Different Cure Periods and Tested at a Confining pressure of 69 KPa.

Sample No.	Cure Period Days	Dry Density KN/m^3	Percent Compac- tion %	Final Moisture Content %	Degree of Saturation %	Peak Strength $\sigma_1-\sigma_3$ KPa	Peak Strength Axial Strain %	Peak Strength Volu- metric Strain %	Residual Strength $\sigma_1-\sigma_3$ KPa	Residual Strength Axial Strain %	Residual Strength Volu- metric Strain %	Initial Tangent Modulus MPa
(1)	(2)	(3)	(4)*	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
S-220-A	7	17.33	97.65	20.80	100.00	565.77	0.43	0.07	321.02	4.71	4.19	220.80
S-217-A	14	17.19	96.94	20.39	97.94	585.69	0.35	0.05	288.10	3.58	3.74	248.40
S-220-B	28	17.11	96.42	20.70	100.00	560.95	0.43	-0.07	270.41	3.96	3.55	224.28

Note: 1 KPa = 0.145 psi; 1 KN/m^3 = 6.36 pcf

* Based on standard Proctor

volumetric change-strain diagrams are illustrated in Fig. 4.20. When samples are allowed to cure out of wax, they gain higher strength compared to those cured in wax as we have discussed earlier. This high strength depends partly on the moisture content at testing, which is a function of the cure period. This relatively higher strength attained is reduced when the sample is saturated prior to testing. The reduction can be as high as 40% from that of the unsaturated undrained conditions on a sample cured out of wax for the same period and tested in unsaturated undrained condition. This reduction does not appear to be a function of the cure period (see Fig. 4.20). Samples cured for 7, 14, and 28 days out of wax and then saturated and tested in drained condition exhibited same stress strain curve (Fig. 4.20) with almost the same principal stress difference, residual stress difference and initial tangent modulus values. These curves were compared with curves for samples cured out of wax for 14 days but tested in unsaturated undrained condition and compared also with samples cured in wax for 14 days and tested in unsaturated undrained as well as drained tests (See Fig. 4.21)

The saturated, originally dry samples exhibited higher strength than those cured in wax and tested in either unsaturated undrained or drained conditions. This could be due to some desiccation bonds which were formed during the drying process. The stress--strain curves (Fig. 4.21 show that samples cured out of wax and tested in unsaturated undrained condition have higher strength values than those tested in drained condition. This could be explained by the fact that when water was added to those dry specimens the strength

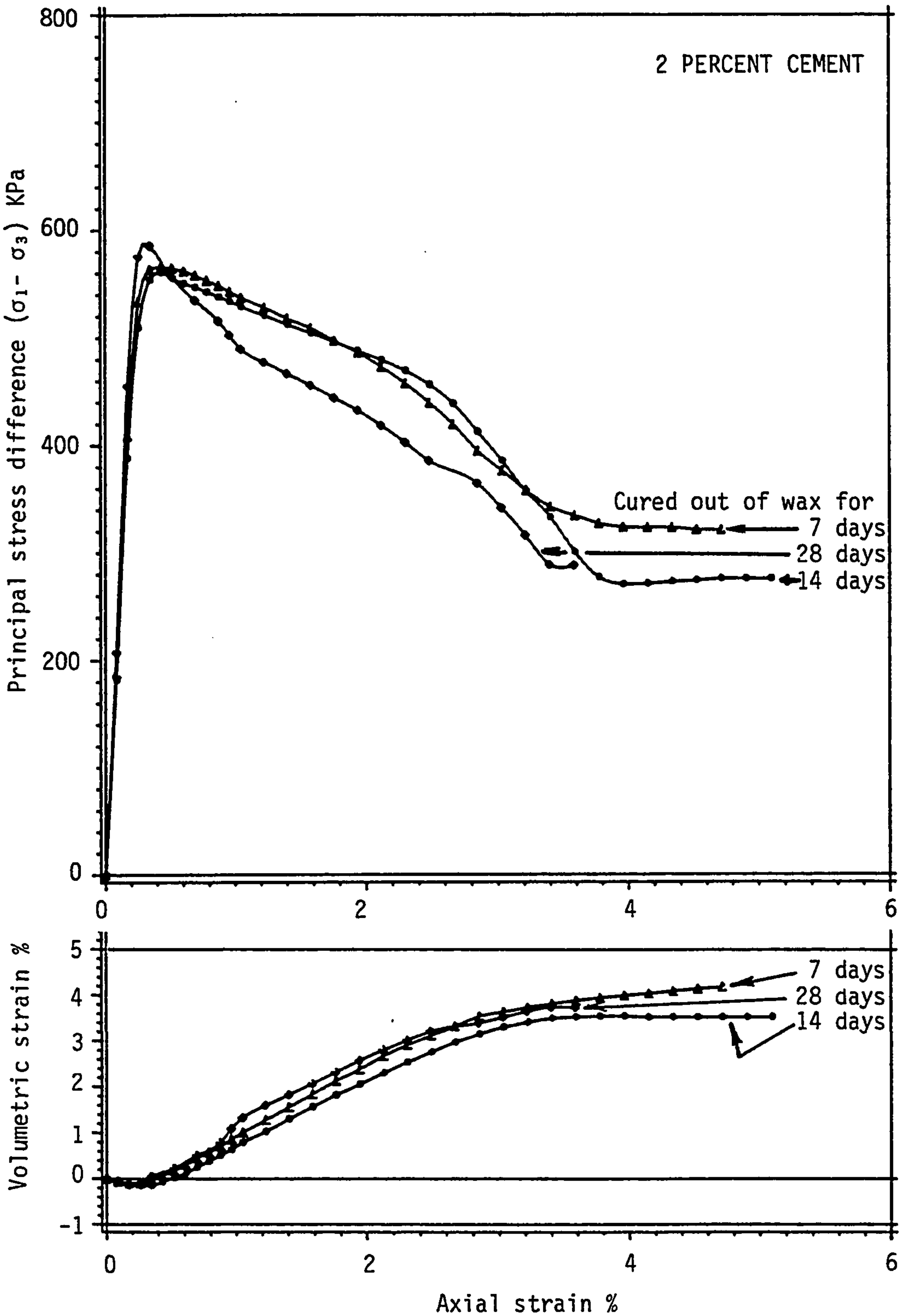


Fig. 4.20: Drained static triaxial stress-strain curves for samples cured out of wax for varying periods and tested at a confining pressure of 69 KPa.

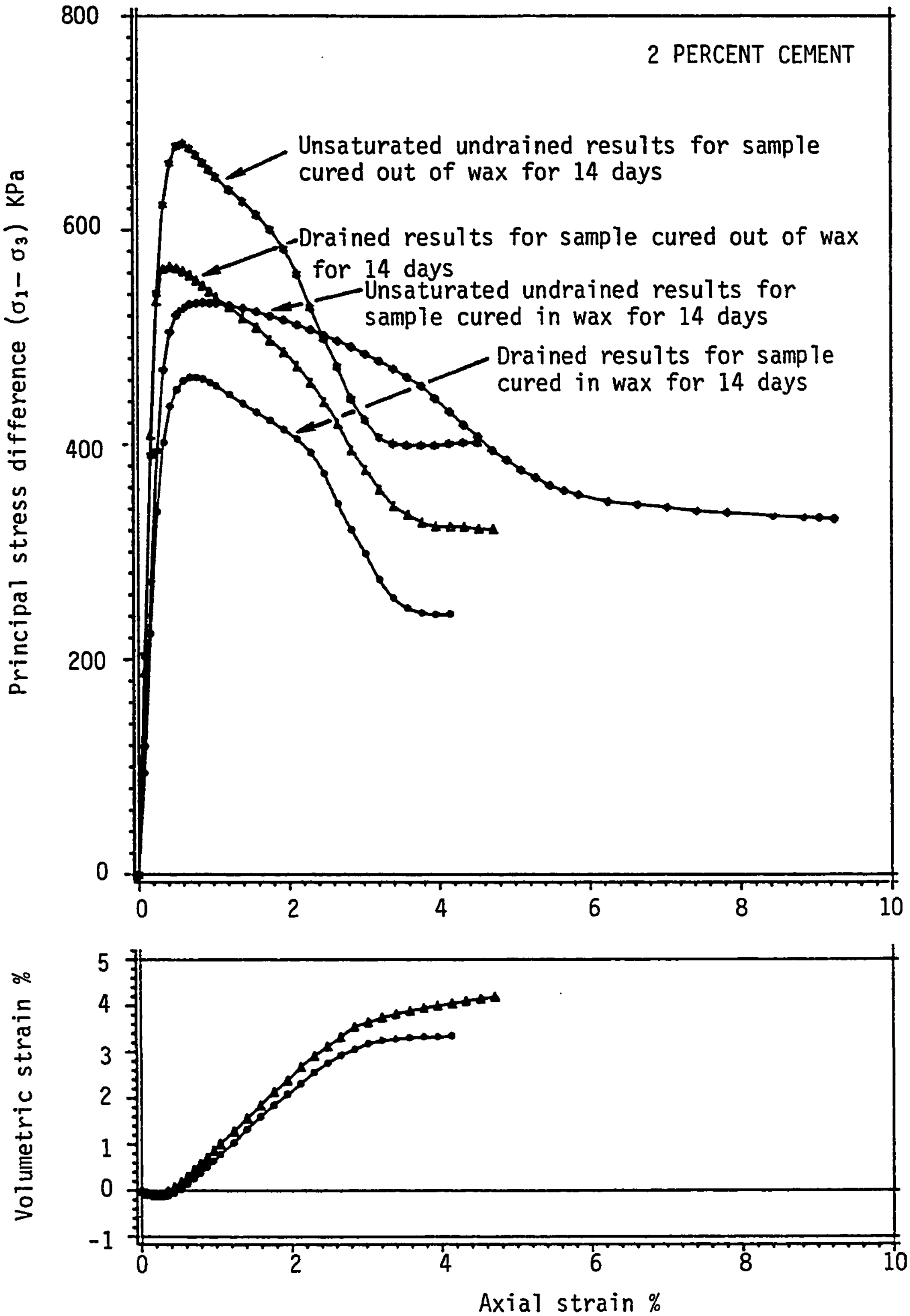


Fig. 4.21: Static triaxial stress-strain curves for samples tested at a confining pressure of 69 KPa, showing differences in test results due to testing procedure (unsaturated undrained versus drained), cure type (in wax versus out of wax).

component due to capillary forces was lost and the sample was weakened. The increase in volume of samples cured out of wax (4%) is little more than the increase in volume for specimens cured in wax (3%), and it seems to be about the same for all dry specimens. Residual strength values did not change and show comparable values irrespective of testing method or cure period since the main contribution comes from the frictional component which is dependent on the residual angle of internal friction which remain constant for all specimens.

Test results support the view that peak strength, residual strength, initial tangent modulus and behavior of samples dried beyond a certain limit and then saturated, remain about constant regardless of the cure period, or how a specimen becomes dry beyond that set limit.

4.2.5 Effect of Cement content

The effect of percentage of cementing agent added to the sand, was studied for specimens cured in wax for 7 and 14 days and tested in unsaturated undrained condition. All other variables were kept constant, except percent portland cement added. Test results are summarized in Table 4.6 for specimens cured in wax for 7 days and in Table 4.7 for specimens cured in wax for 14 days. Stress-strain diagrams are plotted in Figures 4.22 and 4.23 for specimens cured in wax for 7 and 14 days respectively.

Table 4.6: Results of Unsaturated Undrained Static Triaxial Tests of Cemented Sand Samples with Different Percentages of Portland Cement, Cured in Wax for 7 Days and Tested at a Confining Pressure of 69 KPa.

Sample No.	Cement Content %	Dry Density KN/m^3	Percent Compaction %	Final Moisture Content %	Peak Strength $\sigma_1 - \sigma_3$ KPa	Peak Strength Axial Strain %	Residual Strength $\sigma_1 - \sigma_3$ KPa	Residual Strength Axial Strain %	Initial Tangent Modulus MPa
(1)	(2)	(3)	(4)*	(5)	(6)	(7)	(8)	(9)	(10)
S-101-A	1	16.96	N.A	N.A	356.75	1.93	277.16	7.81	78.79
S-101-B	1	17.15	N.A	N.A	353.84	1.76	272.91	8.21	79.99
S-205-A	2	17.15	96.65	7.48	476.58	1.40	333.41	5.84	133.11
S-302-A	3	17.25	N.A	7.33	617.91	0.61	266.25	4.89	223.13
S-401-A	4	17.50	N.A	6.99	815.80	0.61	295.93	3.40	306.40
S-401-B	4	17.49	N.A	6.96	794.56	0.70	341.54	3.77	298.71

Note: 1 KPa = 0.145 psi; 1 KN/m^3 = 6.36 pcf

* Based on standard Proctor N.A = Not available

Table 4.7: Results of Unsaturated Undraied Static Triaxial Tests of Cemented Sand Samples with Different Percentages of Portland Cement, Cured in Wax for 14 Days and Tested at a Confining Pressure of 69 KPa.

Sample No.	Cement Content %	Dry Density KN/m^3	Percent Compaction %	Final Moisture Content %	Peak Strength $\sigma_1 - \sigma_3$ KPa	Peak Strength Axial Strain %	Residual Strength $\sigma_1 - \sigma_3$ KPa	Residual Strength Axial Strain %	Initial Tangent Modulus MPa
(1)	(2)	(3)	(4)*	(5)	(6)	(7)	(8)	(9)	(10)
S-102-A	1	17.20	N.A	7.58	374.89	1.76	276.41	6.23	91.89
S-211-A	2	17.16	96.70	7.34	531.97	1.23	339.18	4.92	157.40
S-219-B	2	17.19	96.88	7.31	532.35	0.87	330.31	9.26	154.40
S-227-A	2	17.14	96.61	7.28	537.70	0.78	319.58	7.02	156.59
S-301-A	3	17.34	N.A	7.32	680.33	0.61	348.21	5.27	258.65
S-402-A	4	17.59	N.A	7.01	963.41	0.61	370.80	3.58	300.16
S-403-A	4	17.50	N.A	7.07	964.04	0.52	413.48	6.63	312.65

Note: 1 KPa = 0.145 psi; 1 KN/m^3 = 6.36 pcf

* Based on standard Proctor N.A = Not available

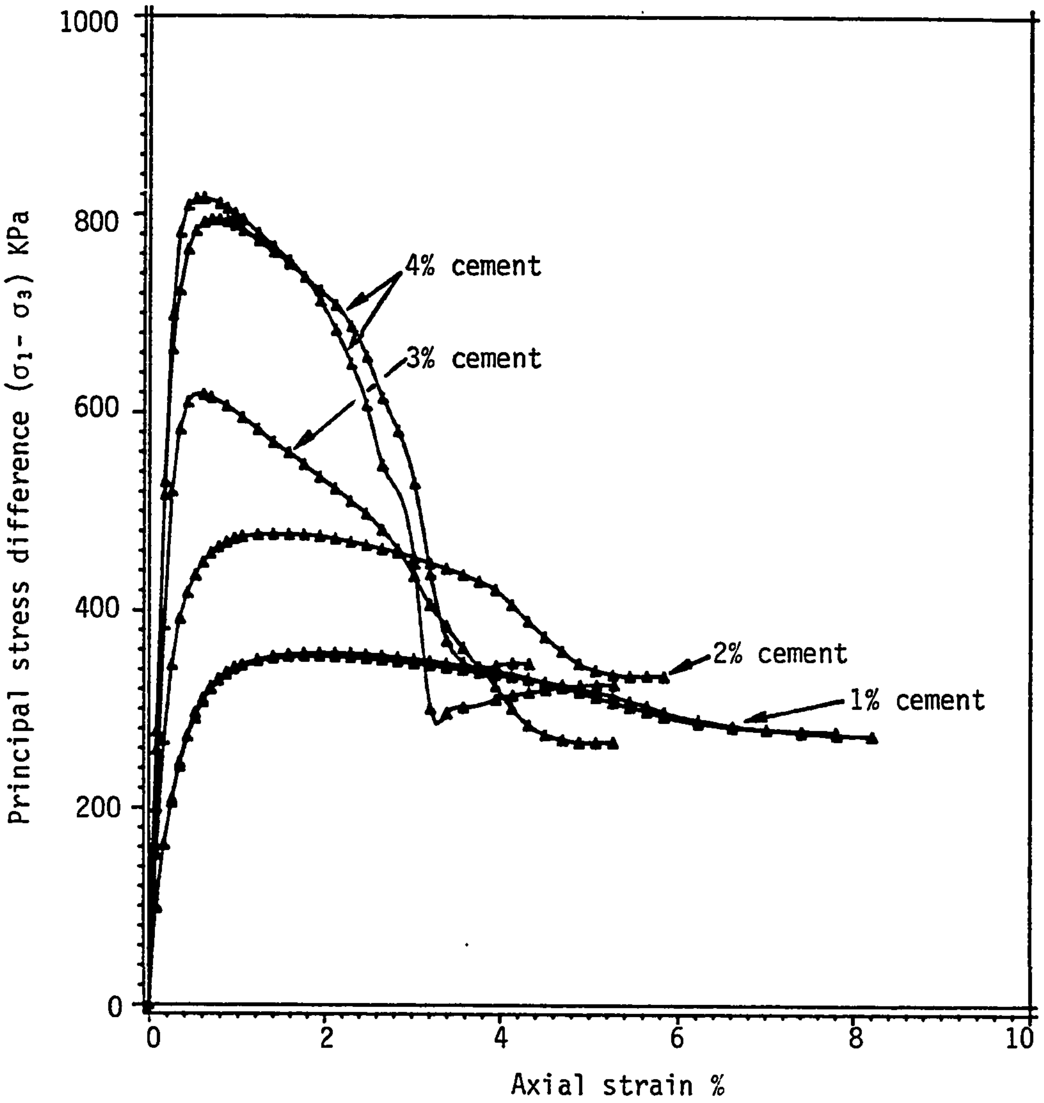


Fig. 4.22: Unsaturated undrained static triaxial stress-strain curves for samples with different cement content, cured in wax for 7 days and tested at a confining pressure of 69 KPa.

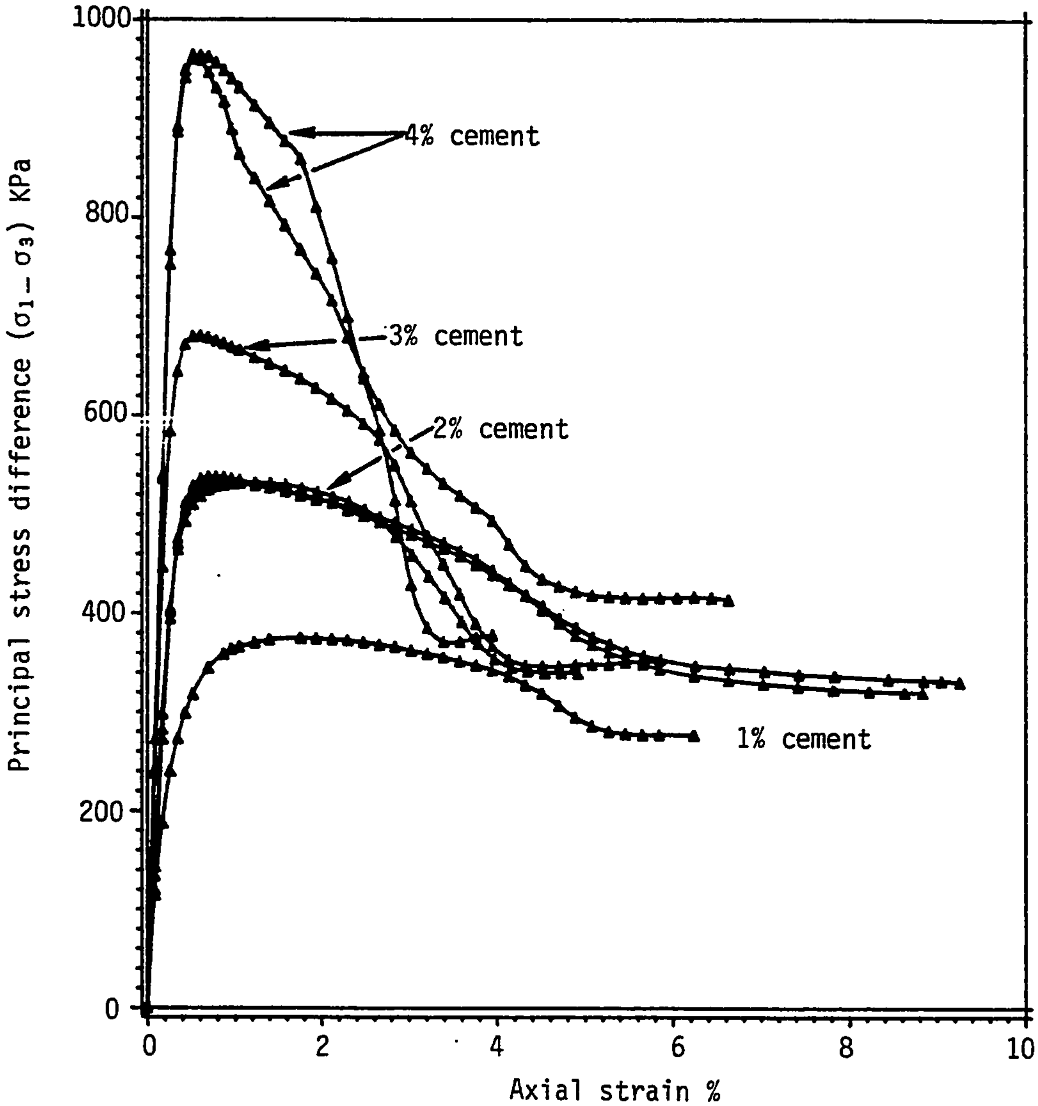


Fig. 4.23: Unsaturated undrained static triaxial stress-strain curves for samples with different cement content, cured in wax for 14 days and tested at a confining pressure of 69 KPa.

4.2.5.1 Peak Strength

Peak strength values increase with increasing cement content as shown in Figures 4.22 and 4.23. The peak values of the deviatoric stress are plotted against cement content in Fig. 4.24 for samples cured for 7 and 14 days. Samples cured in wax for 14 days show higher strength values than those cured in wax for 7 days and the rate of strength increase for 14 days samples is higher than those for 7 days. This is due to the fact that samples with higher percent cement need more time to get the cement hydrated.

4.2.5.2 Residual Strength

Residual strength values appear not to be affected by the amount of cement added. When specimens have failed the cementation contribution disappears and only the frictional component contribution appears effective, which is not much influenced by the cement content. It appears that once the failure stage occurs, cement acts predominantly as a filler (see Figures 4.22 and 4.23).

4.2.5.3 Deformation Modulus Values

Initial tangent modulus values increase with increasing cement content. The initial tangent modulus values were calculated for both the 7 and 14 days cure time and plotted against cement content in Fig. 4.25 on a natural scale. This increase reflects the increase of stiffness of samples with increasing cement content. Increasing the

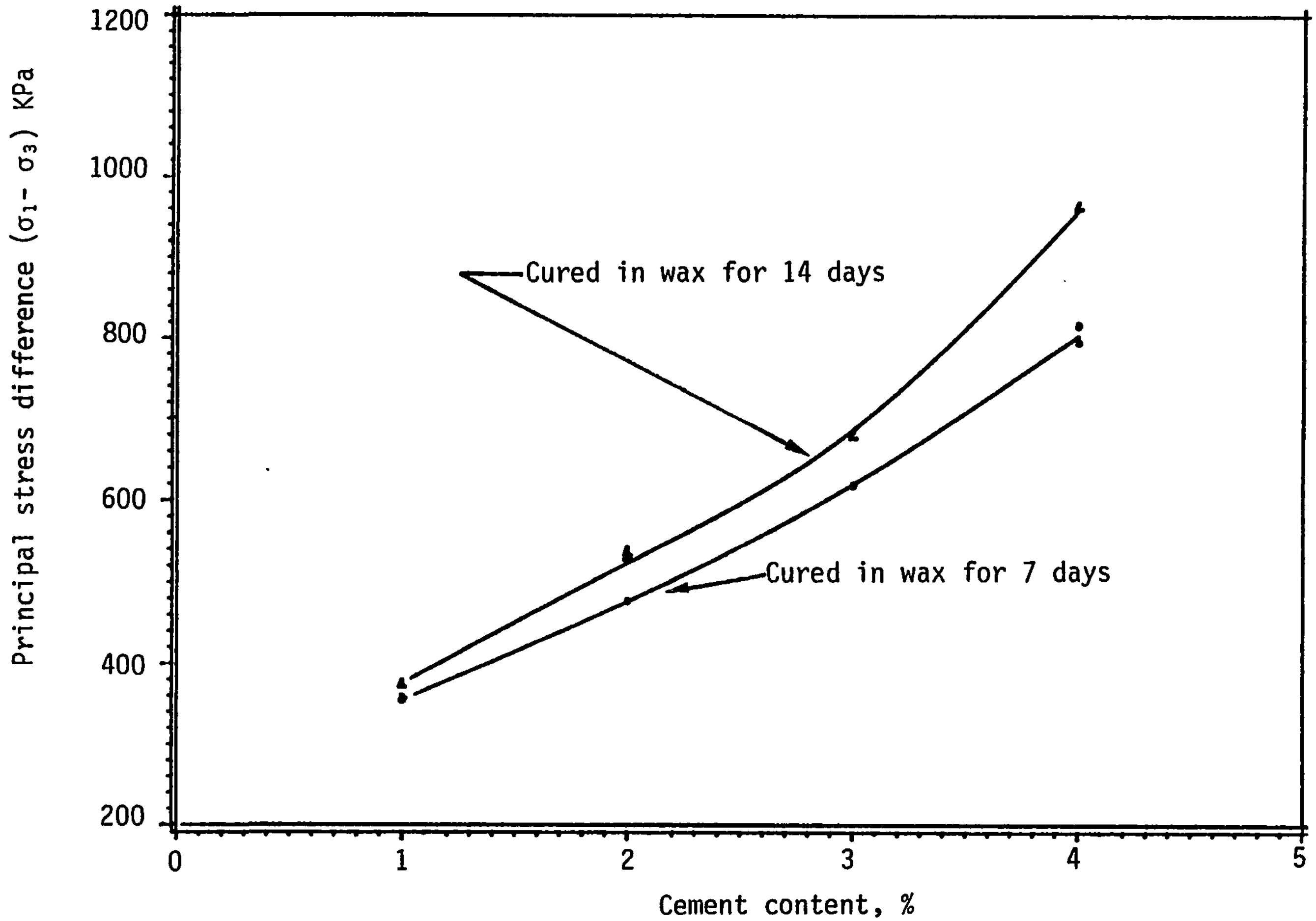


Fig. 4.24: Variation of peak strength with cement content for samples tested at a confining pressure of 69 KPa.

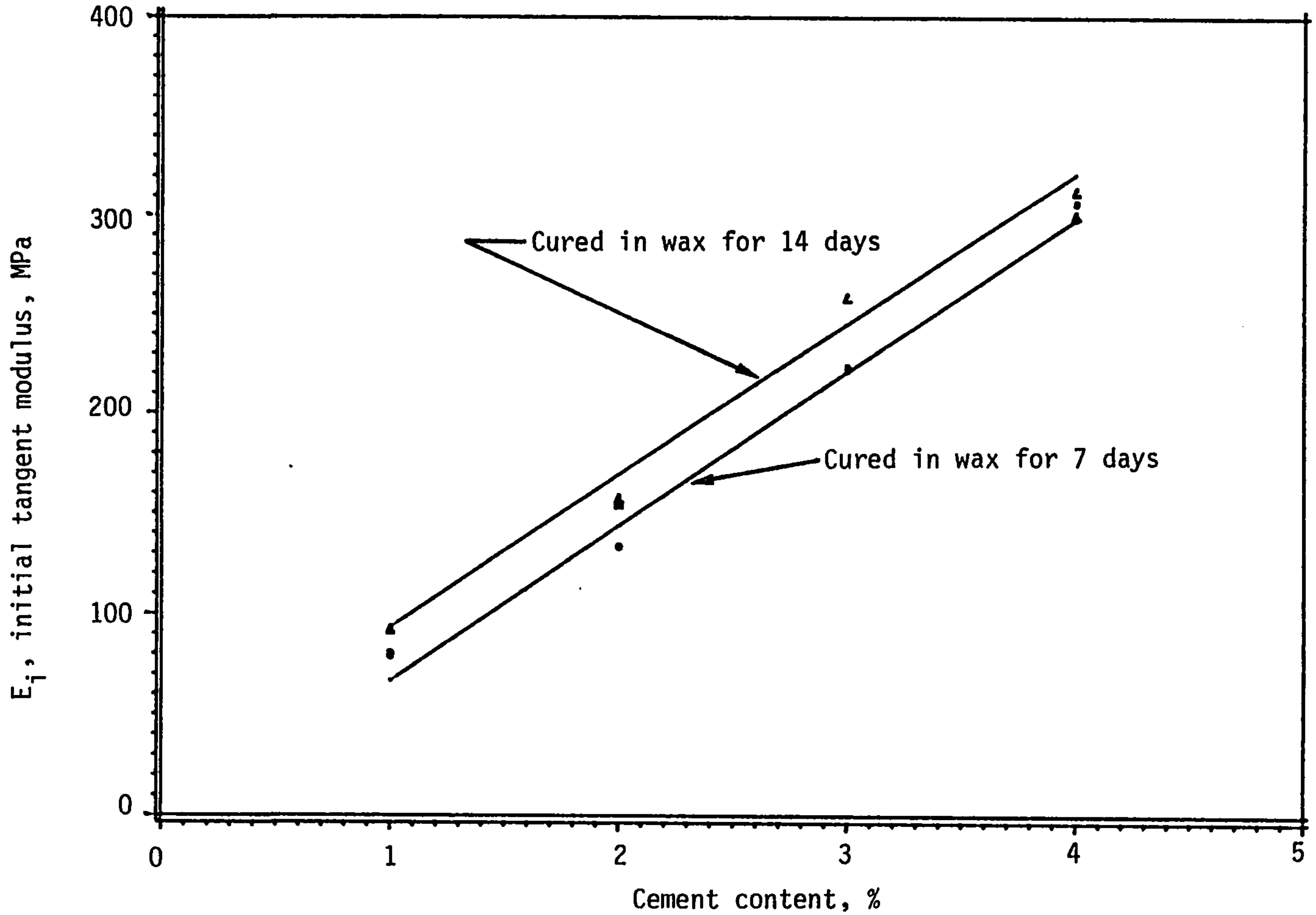


Fig. 4.25: Variation of initial tangent modulus with cement content for samples tested at a confining pressure of 69 KPa.

cement content increases the tendency of the sample towards brittle type behavior whose stress strain is characterized by relatively high modulus, well-pronounced peak strength and rather sudden failure.

4.2.6 Effect of Density

Densities of specimens molded with 2% portland cement, allowed to cure in wax for 14 days and tested at a confining pressure of 69 KPa (10 psi) in unsaturated undrained condition, were varied by changing the energy input during compaction. This change was brought about by increasing the number of blows per layer using 3, 6, 10, 15, 20 and 25 blows per layer. This change in compaction energy resulted in a change of the degree of compaction and consequently change in density. Test results are tabulated in Table 4.8 and the resulting stress-strain curves are plotted in Fig. 4.26. Dry density is plotted on a natural scale in Fig. 4.27 against number of blows per layer and on a semi-logarithmic scale in Fig. 4.28. Figure 4.29 shows dry density as a function of percent compaction.

Changing the amount of compaction energy for samples cemented with 2% cement results in changing the sample's density as shown in Fig. 4.28. The relation between density and no of blows per layer (N) may be expressed by the equations:

$$\gamma = 15.57 \times N^{0.037} \qquad (4.3)$$

Table 4.8: Results of Unsaturated Undrained Static Triaxial Tests of Cemented Sand Samples with 2% Portland Cement with Different Densities Cured in Wax for 14 Days and Tested at a Confining Pressure of 69 KPa.

Sample No.	No.of Blows per Layer N	Dry Density KN/m^3	Percent Compaction %	Final Moisture Content %	Peak Strength		Residual Strength		Initial Tangent Modulus MPa
					$\sigma_1 - \sigma_3$ KPa	Axial Strain %	$\sigma_1 - \sigma_3$ KPa	Axial Strain %	
(1)	(2)	(3)	(4)*	(5)	(6)	(7)	(8)	(9)	(10)
S-225-A	3	16.15	91.03	7.22	384.19	0.61	270.12	9.44	111.73
S-225-B	3	16.17	91.14	7.31	376.11	0.61	268.72	9.45	112.52
S-226-A	6	16.73	94.29	7.32	451.28	0.70	304.73	9.04	135.38
S-226-B	6	16.58	93.45	7.33	440.41	0.78	303.65	9.45	135.26
S-221-A	10	17.04	96.05	7.35	513.55	0.70	350.55	7.82	148.99
S-221-B	10	16.91	95.29	7.40	498.81	0.96	345.81	7.02	138.21
S-211-A	15	17.16	96.70	7.34	531.97	1.23	339.18	4.92	157.40
S-219-B	15	17.19	96.88	7.31	532.35	0.87	330.31	9.26	154.40
S-227-A	15	17.14	96.61	7.28	537.70	0.78	319.58	7.02	156.59
S-222-A	20	17.30	97.50	7.37	586.66	0.96	339.35	4.32	172.50
S-222-B	20	17.39	98.02	7.36	571.70	1.04	368.79	5.83	167.99
S-223-A	25	17.54	98.86	7.25	607.06	0.87	326.47	7.42	179.40
S-223-B	25	17.60	99.18	7.38	608.30	0.96	331.14	9.86	169.26

Note: 1 KPa = 0.145 psi; 1 KN/m^3 = 6.36 pcf

* Based on standard Proctor

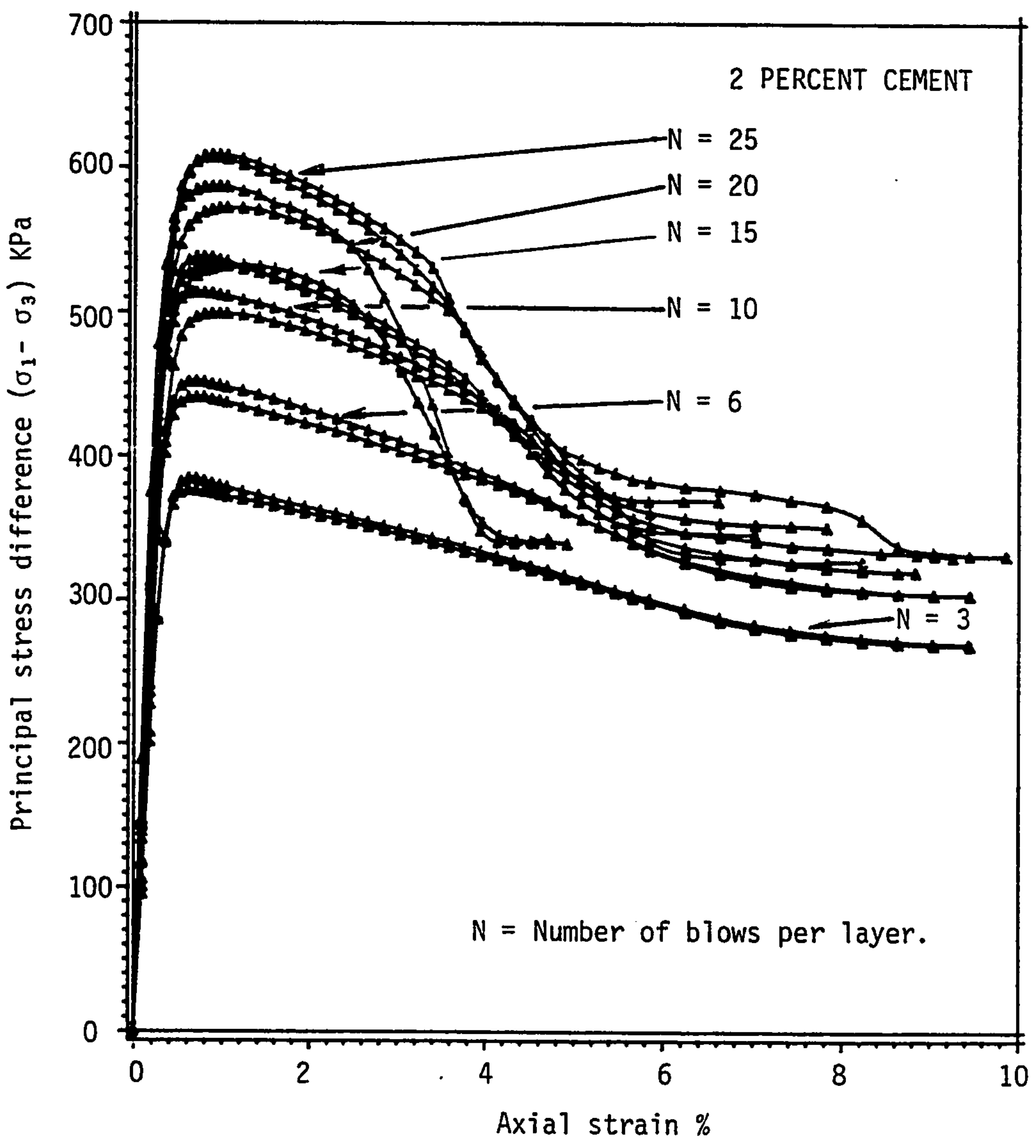


Fig. 4.26: Unsaturated undrained static triaxial stress-strain curves for samples with different densities and tested at a confining pressure of 69 KPa.

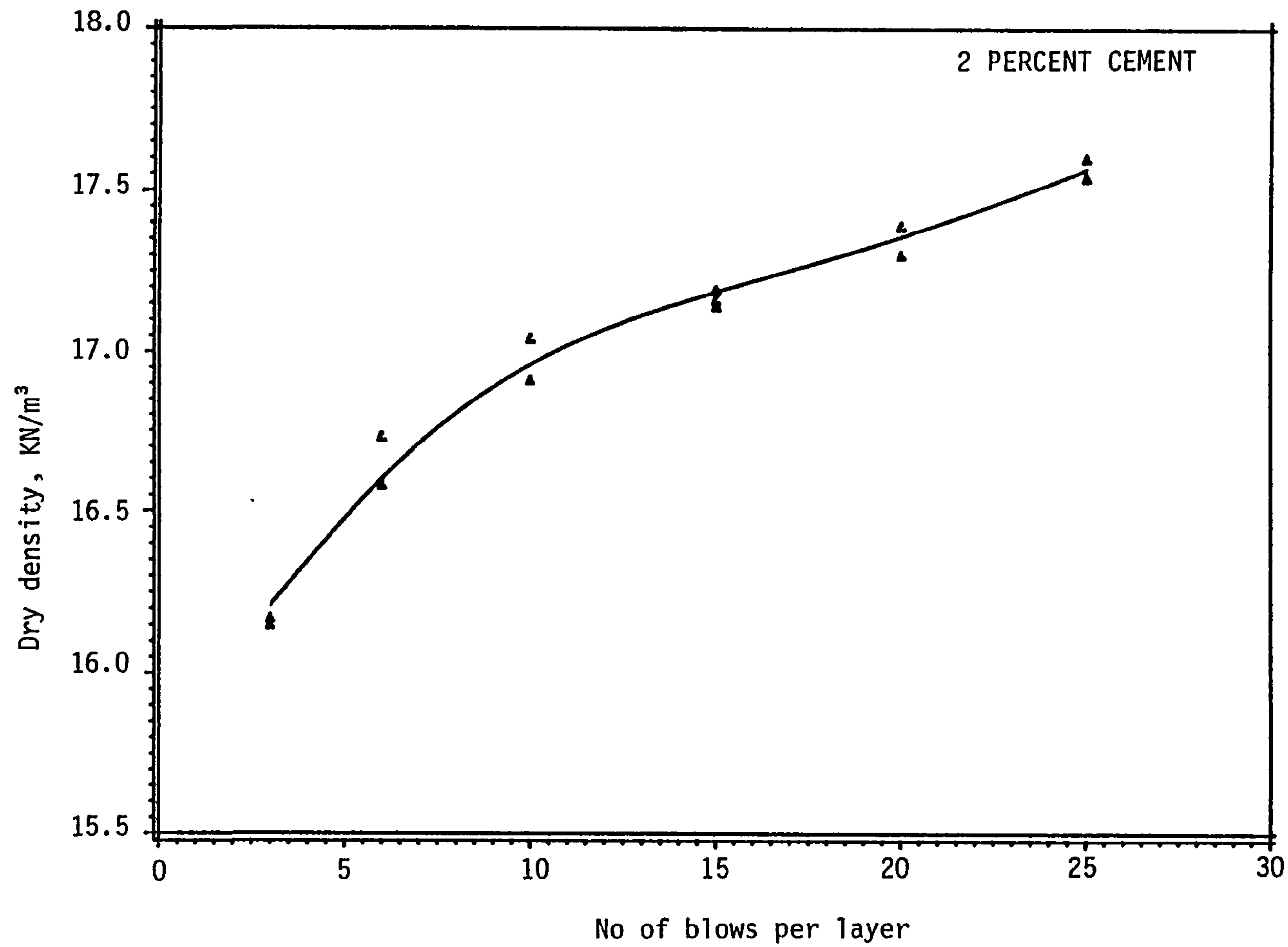


Fig. 4.27: Variation of dry density with No of blows per layer.

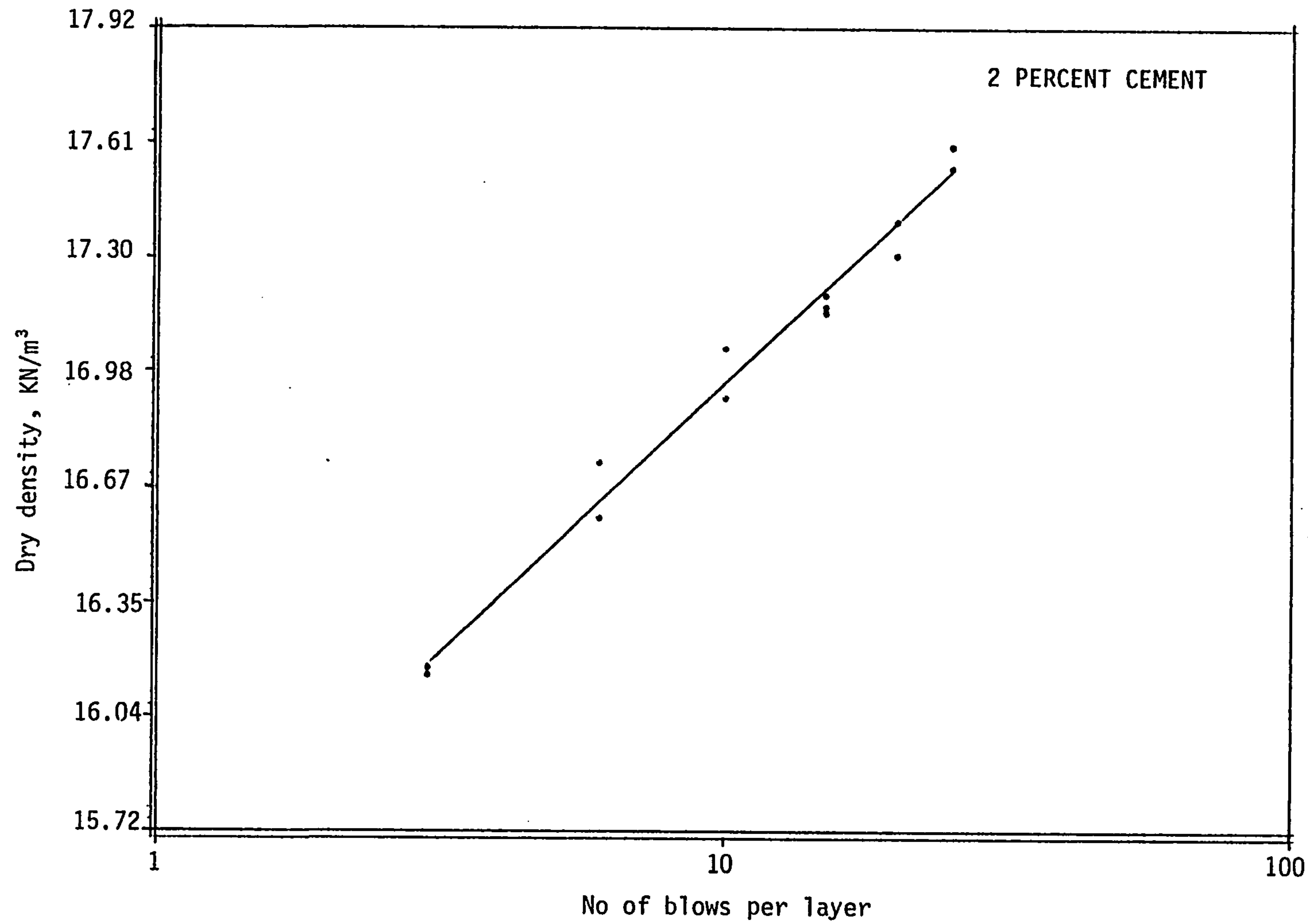


Fig. 4.28: Variation of dry density with no of blows per layer.

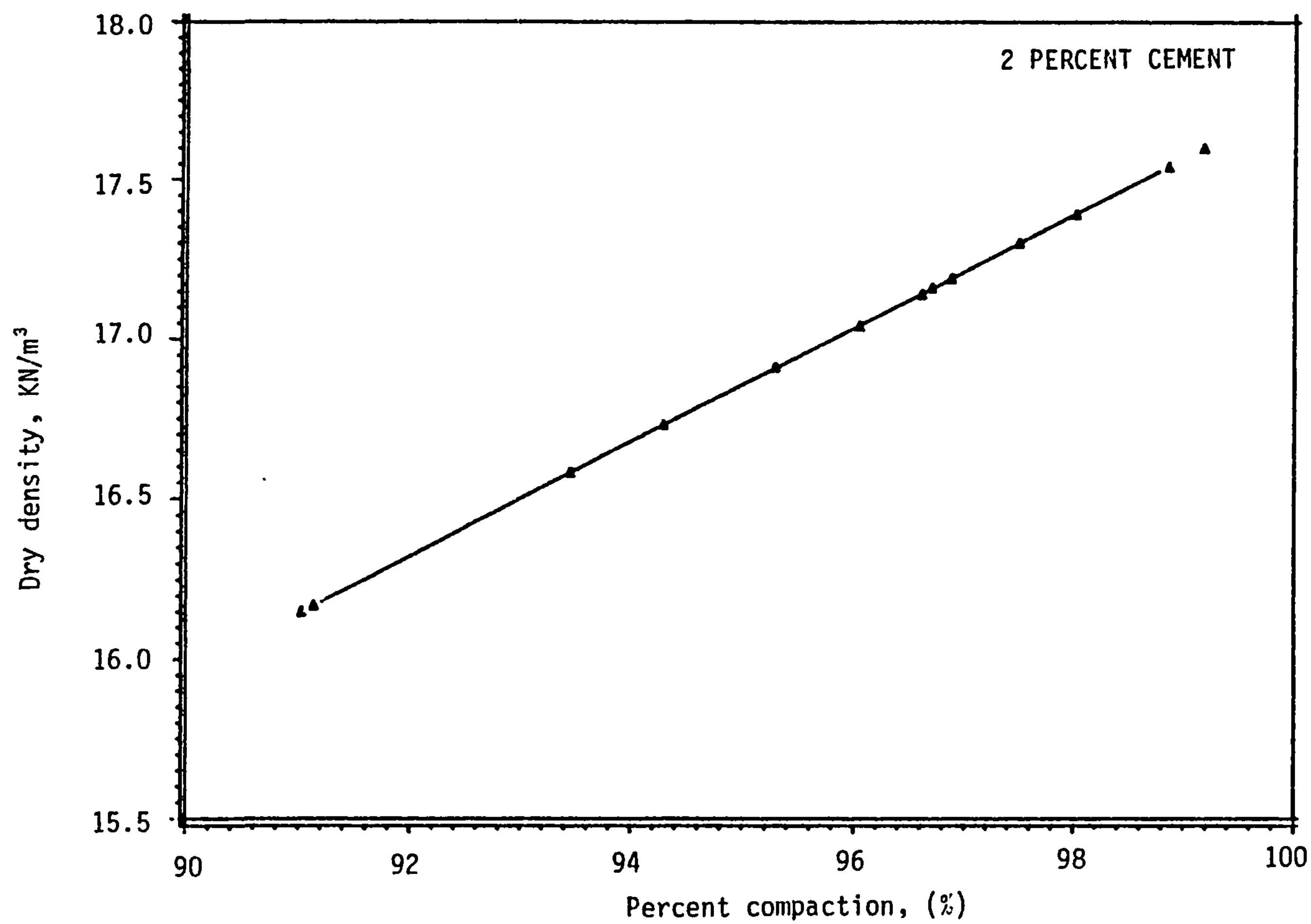


Fig. 4.29: Variation of dry density with percent compaction for samples densified by a drop hammer weighing 2.42 kg, using different dropes per layer for different samples and three layers per sample for all samples.

where N is the number of blows per layer and γ is the average sample density in KN/m^3. The degree of compaction ranges from 91% of the maximum dry density (based on the standard Proctor which was obtained according to ANSI (American National Standards Institute)/ASTM D 558 and shown in Fig. 4.30) for N=3 to 99.2% for N-25 blows per layer.

4.2.6.1 Peak Strength

Peak strength values increase with increasing dry density of test specimens. Peak deviatoric stress values are plotted against dry density on a natural scale in Fig. 4.31. This increase in peak strength is mainly due to the close packing of the cement/sand grains.

4.2.6.2 Residual Strength

The residual strength values seem to increase with increasing density but this does not seem to hold true for all samples tested (see Fig. 4.26). Thus we can not conclude that residual strength values increase with increasing density because of the failure surface shape which plays a role in the residual strength value.

4.2.6.3 Initial Tangent Modulus

The initial tangent modulus values increase as the dry density increases. The initial tangent modulus values were calculated and plotted against dry density on a natural scale in Fig. 4.32.

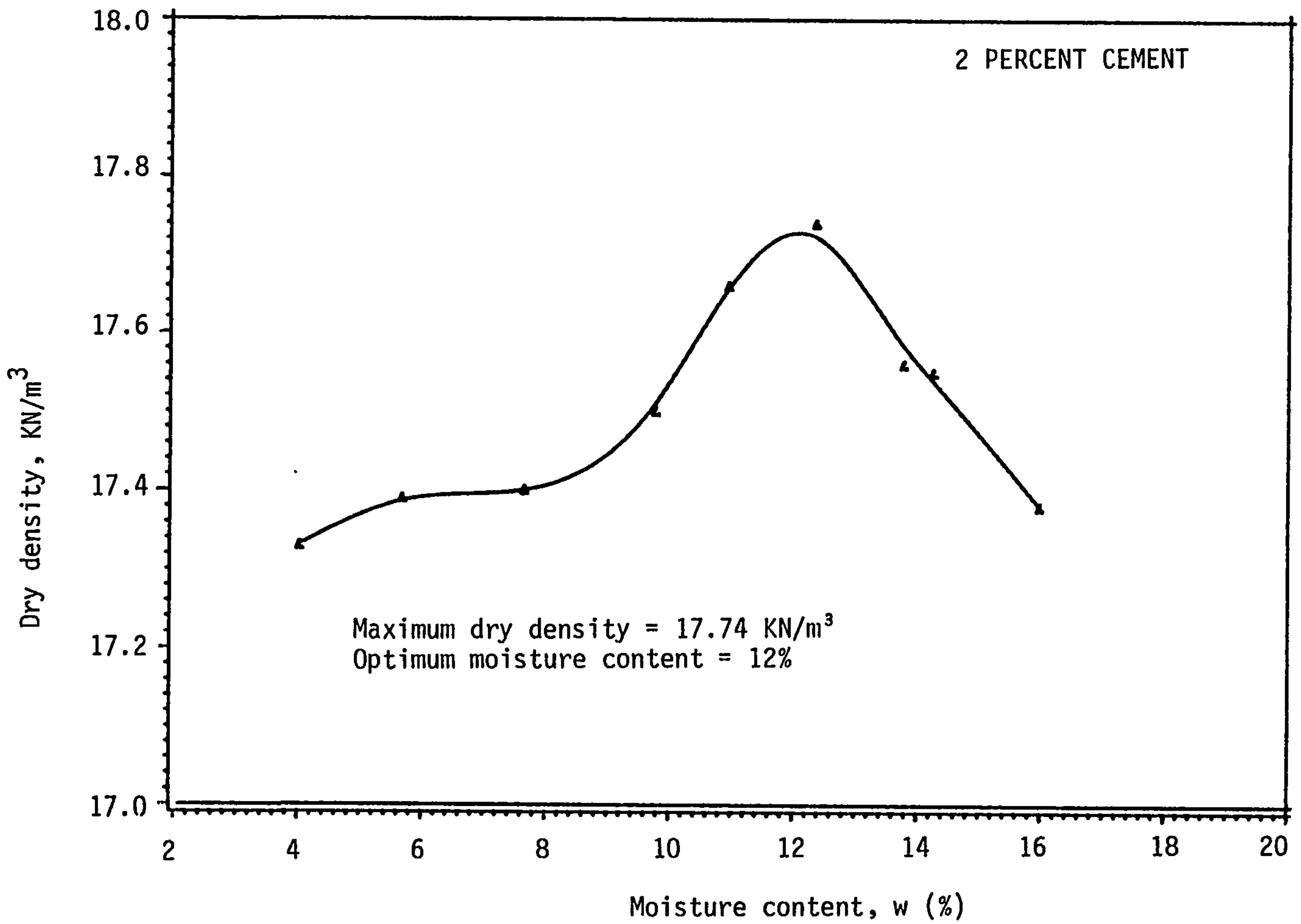


Fig. 4.30: moisture—density relationship for cemented sands.

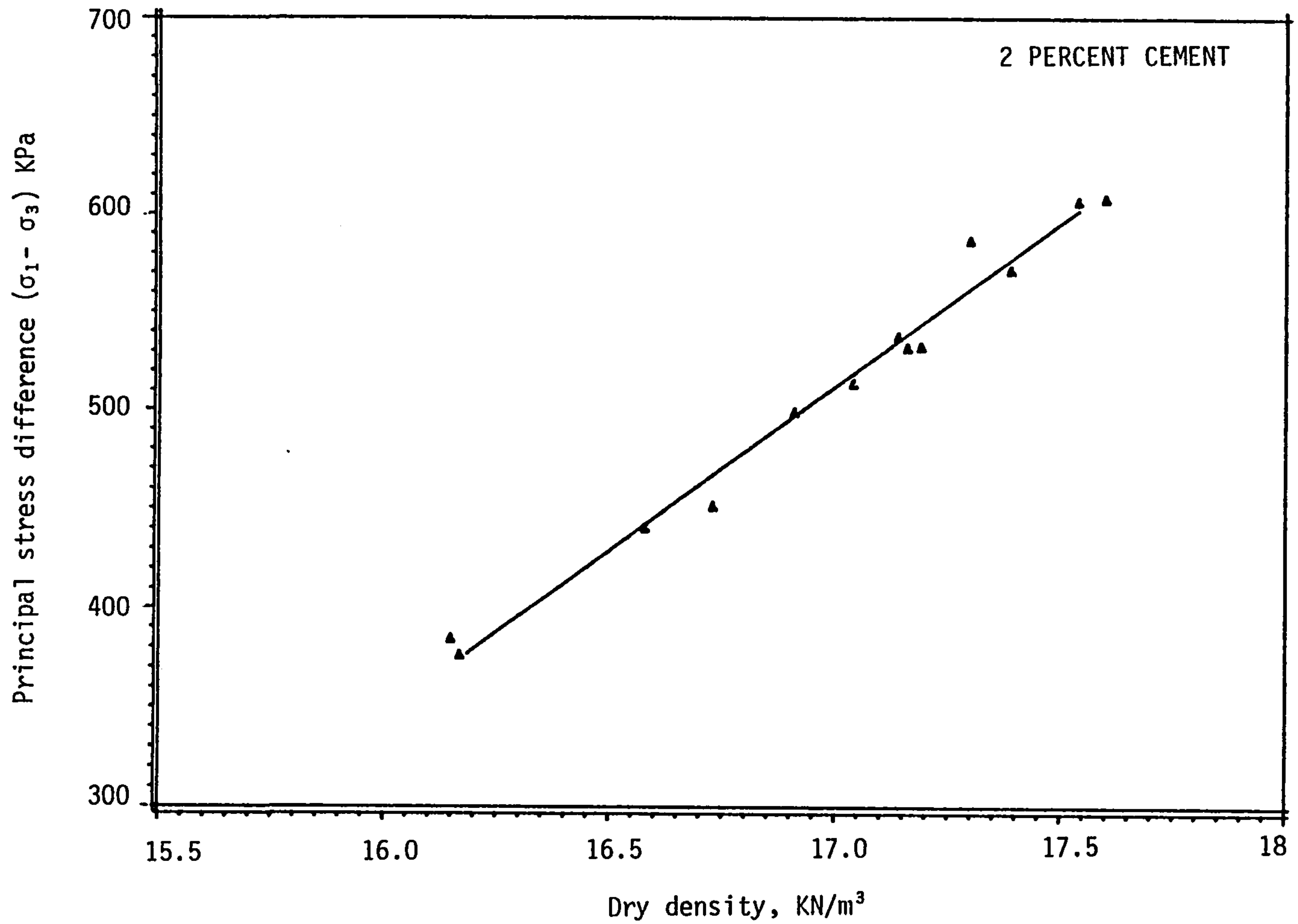


Fig. 4.31: Variation of peak strength with dry density for samples cured in wax for 14 days and tested at a confining pressure of 69 KPa.

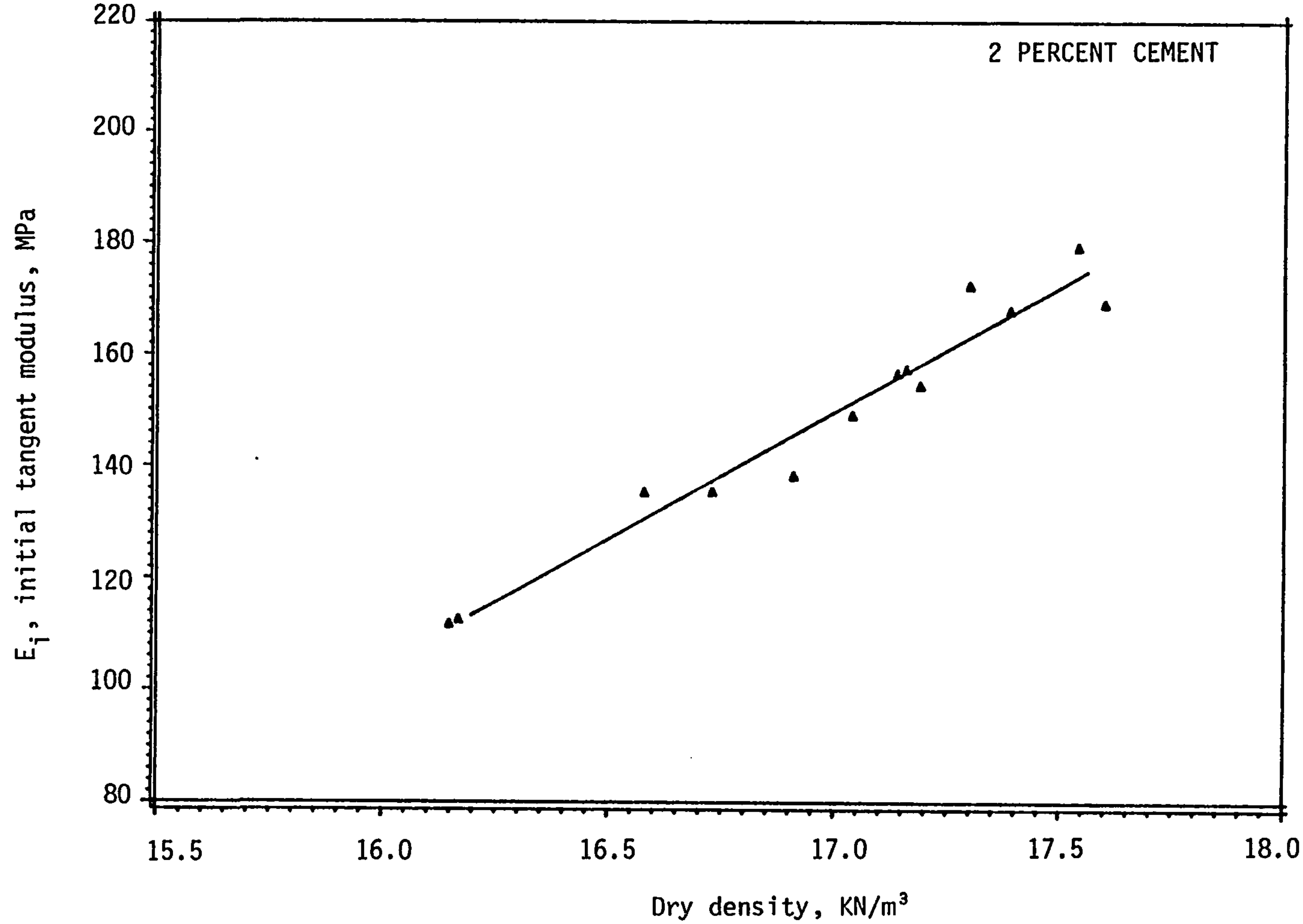


Fig. 4.32: Variation of initial tangent modulus with dry density for samples cured in wax for 14 days and tested at a confining pressure of 69 KPa.

4.2.7 Results of Tests on Reconstituted Specimens

It was believed to be of interest to trace the stress-strain behavior of reconstituted samples made from previously utilized samples subjected to degradation. Thus used up samples that were originally cemented with 2% portland cement, and were tested until failure were collected and broken into small pieces until all material passed No. 4 sieve. A predetermined amount of the minus No.4 material was weighed and about 8% water was added and then mixed in the mechanical mixer in the same manner as freshly prepared specimens but without adding any fresh cement. Reconstituted samples were allowed to cure in wax for 7 and 14 days. Unsaturated undrained static triaxial tests were performed, and test results are shown in table 4.9 with the resulting stress-strain diagrams plotted in Fig. 4.33

The effect of cementation was not noticed on reconstituted samples originally cemented with 2% cement. Great reduction in the peak strength of those reconstituted samples, in comparison to original strength (prior to degradation) were noticed. Reconstituted sample's stress-strain curves were compared with those of fresh samples cured in wax for 7 and 14 days (see Fig. 4.33). As can be seen in Fig. 4.33, while the effect of cementation on peak strength of fresh samples is very evident, its effect on reconstituted samples is completely un-noticed. Additionally, cure period does not seem to affect the strength of reconstituted samples which confirms that cementation due to the hydration process of portland cement is not

Table 4.9: Results of Unsaturated Undrained Static Triaxial Tests of Reconstituted Samples Originally Cemented with 2% Portland Cement, Cured in Wax for Different Periods and Tested at a Confining Pressure of 69 KPa.

Sample No.	Cure Period days	Dry Density KN/m^3	Percent Compaction %	Final Moisture Content %	Peak Strength		Residual Strength		Initial Tangent Modulus MPa
					$\sigma_1 - \sigma_3$ KPa	Axial Strain %	$\sigma_1 - \sigma_3$ KPa	Axial Strain %	
(1)	(2)	(3)	(4)*	(5)	(6)	(7)	(8)	(9)	(10)
R-203-A	7	17.01	95.85	N.A	268.76	2.84	235.71	16.52	66.63
R-203-B	7	17.09	96.33	7.29	273.96	2.66	237.82	15.56	71.30
R-204-A	14	16.92	95.38	7.28	280.59	2.84	233.36	14.18	63.91
S-205-A	7+	17.15	96.65	7.48	476.58	1.40	333.41	5.84	133.11
S-219-B	14+	17.19	96.88	7.31	532.35	0.87	330.31	9.26	154.40

Note: 1 KPa = 0.145 psi; 1 KN/m^3 = 6.36 pcf

* Based on standard Proctor

\+ Fresh samples included for comparison purposes

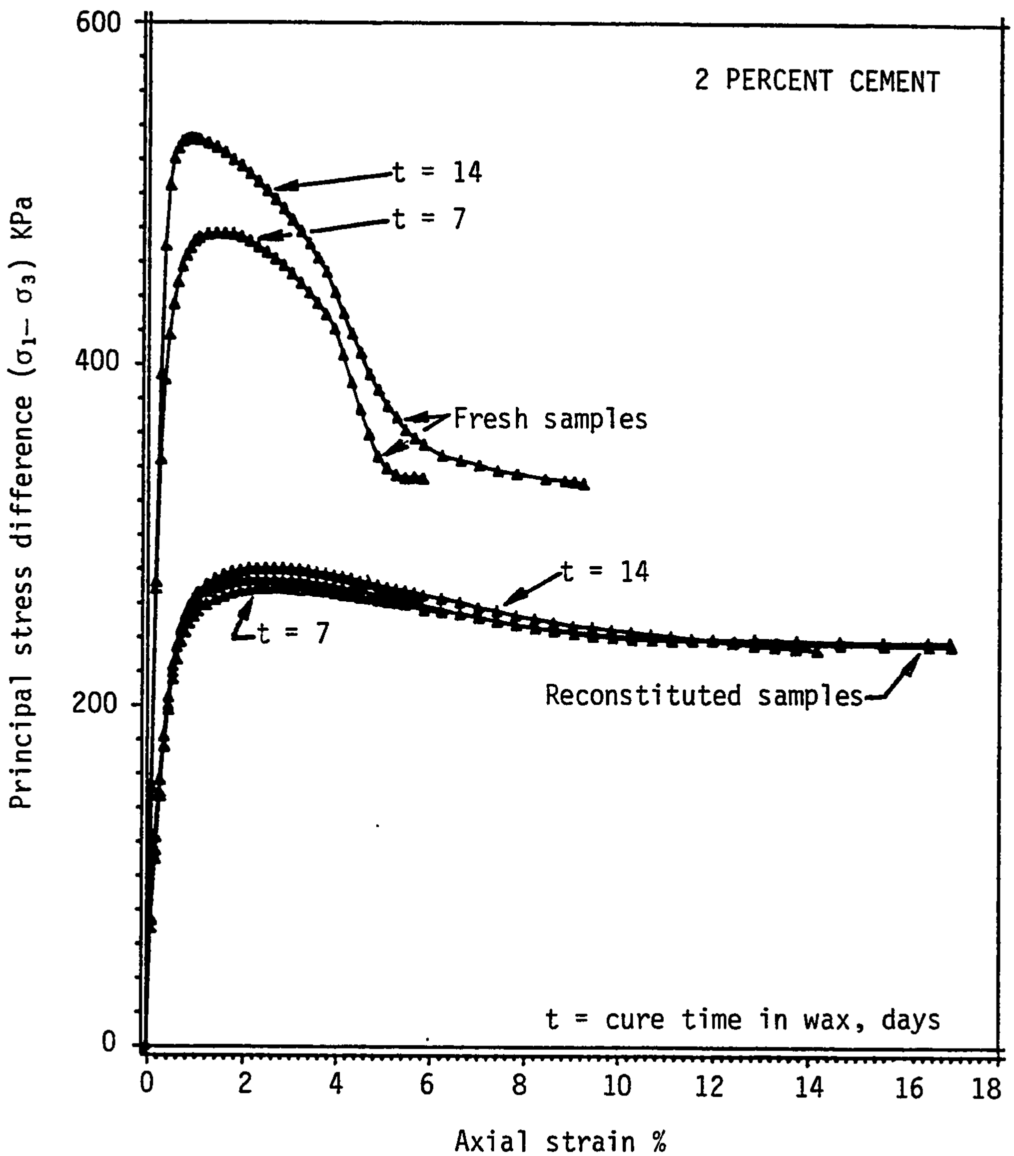


Fig. 4.33: Unsaturated undrained static triaxial stress-strain curves for reconstituted and fresh samples cured in wax and tested at a confining pressure of 69 KPa.

acting in the reconstituted samples. This can well be seen from the stress strain diagrams of Fig. 4.33, where specimens were allowed to cure in wax for 7 and 14 days but the stress strain curve was almost the same for the three specimens regardless of cure period. Additionally reconstituted specimens have exhibited a ductile type failure even at high axial strain levels, and their residual strength was relatively high compared to their peak values i.e. it is more than 83% of the peak value in all specimens tested. Thus the effect of the available cement in these reconstituted samples is to contribute towards the increase in fine content, since the portland cement in this case appears to act as a filler and not as a cementing agent. As anticipated, the increase in hydrated cement (acting as a filler) is not coupled with any increase in peak strength values. Initial tangent modulus values of reconstituted samples were about the same regardless of cure period.

The residual strength values for reconstituted samples are well below those of fresh samples. This is expected since the reconstituted samples are not cemented and thus are softer and possess lower strength. The failure mode of reconstituted samples was primarily by expansion and bulging as typically shown in plate 4.3.

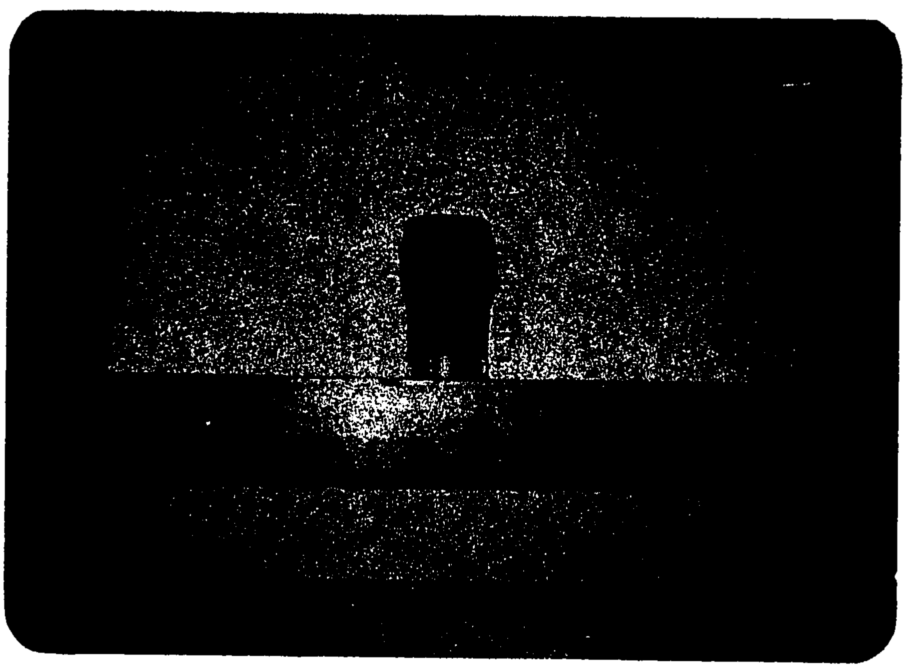


Plate 4.3: Typical bulging failure mode.

4.3 Calcium Carbonate

carbonate sediments are wide spread in many regions of the world such as the southern shores of the Arabian Gulf. Sediments referred to as 'sabkha' in the Arabic-speaking countries contain carbonate soils in addition to other type of marine and eolian deposits. Carbonate soils present special problems to geotechnical engineers. Carbonate acts as cementing agent and are in themselves weak when compared with quartz sand. One of the noted features of these deposits is the fluctuation in their strength as it gets affected by drying and wetting cycles. Usually when these deposits are dry, cementation bonds due to carbonates are at their peak value. Upon wetting or inundation some of these bonds get weaker and consequently their strength decreases appreciably. Undisturbed samples of carbonate soils and carbonate sands in particular can not be obtained easily because of their friability and their delicate nature. An attempt was made here to simulate the behavior and cementation development in carbonate sands by means of laboratory specimens. The laboratory samples were made by mixing a selected dune sand with calcium carbonate in a powder form plus water. The main purpose of such a trial is to see whether cementation will be produced this way, and how it will affect the strength and stress-strain behavior of the artificially cemented sand. It was not intended to develop a mixing procedure nor to study the effect of different parameters on the characteristics of the mix.

In this thesis calcium carbonate was selected as another cementing agent in the carbonate family to compare with portland cement. Different percentages of $CaCo_3$, different cure periods and two types of cure were tried. Samples with 2% and 3% calcium carbonate by weight of sand were prepared and allowed to cure in wax until tested. Samples with 2%, 3% and 4% calcium carbonate by weight of sand were prepared and allowed to cure in wax for 7 days and then were taken out of wax and allowed to cure for varying periods. Unsaturated undrained static triaxial tests were performed on all specimens. Test results are shown in Table 4.10 for specimens cured in wax only and in Table 4.11 for specimens cured in wax for 7 days and then out of wax for varying periods. Stress-strain diagrams are shown in Fig. 4.34 for samples cured in wax and in Fig. 4.35 for samples cured in wax for 7 days and out of wax for varying periods. Peak values of the deviatoric stress for all samples were plotted on a natural scale against moisture content at testing time, and are shown in Fig. 4.36 for all specimens tested for both cure types. Initial tangent modulus values for all samples tested in both cure types are plotted against moisture content at testing time in Fig. 4.37.

The main purpose of using $CaCo_3$ is to compare its effect with the effect of portland cement, and not to study the properties and behavior of sand mixed with calcium carbonate. To the author's knowledge there is nothing in the literature concerning addition of low percentages (less than 4% by weight) of calcium carbonate, and therefore the behavior of such a mix is not well documented. All work done in the laboratory on soils and carbonate mixes deals with high

Table 4.10: Results of Unsaturated Undrained Static Triaxial Tests of Sand Mixed with Different Percentages of Calcium Carbonate, Cured in Wax for Different Periods and Tested at a Confining Pressure of 69 KPa.

Sample No.	Cure Period days	Carbonate Content %	Dry Density KN/m^3	Final Moisture Content %	Peak Strength $\sigma_1 - \sigma_3$ KPa	Peak Strength Axial Strain %	Residual Strength $\sigma_1 - \sigma_3$ KPa	Residual Strength Axial Strain %	Initial Tangent Modulus MPa
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
C-201-A	7	2	17.39	7.69	247.54	1.94	209.73	9.45	71.53
C-201-B	7	2	17.26	7.55	250.53	1.94	211.45	11.15	68.43
C-202-A	14	2	17.48	7.69	255.09	1.93	209.66	11.11	74.86
C-202-B	14	2	17.19	7.59	249.56	1.93	218.14	9.43	76.65
C-301-A	7	3	17.41	7.83	248.12	1.93	210.03	11.54	72.77

Note: 1 KPa = 0.145 psi; 1 KN/m^3 = 6.36 pcf

Table 4.11: Results of Unsaturated Undrained Static Triaxial Tests of Sand Mixed with Different Percentages of Calcium Carbonate, Cured for 7 Days in Wax and for Different Periods Out of Wax and Tested at a Confining Pressure of 69 KPa.

Sample No.	Cure Period Out of Wax days	Carbonate Content %	Dry Density KN/m^3	Final Moisture Content %	Peak Strength $\sigma_1 - \sigma_3$ KPa	Peak Strength Axial Strain %	Residual Strength $\sigma_1 - \sigma_3$ KPa	Residual Strength Axial Strain %	Initial Tangent Modulus MPa
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	
C-206-A	3	2	17.23	3.86	293.88	1.05	244.69	5.65	72.66
C-206-B	3	2	17.20	3.80	286.95	1.40	249.44	5.84	70.52
C-205-A	7	2	17.18	0.51	549.64	0.70	261.49	2.49	144.15
C-205-B	7	2	17.37	0.50	553.89	0.87	289.00	2.84	138.48
C-204-A	14	2	17.25	0.44	588.55	0.70	294.54	3.95	187.23
C-204-B	14	2	17.25	0.44	595.80	0.78	259.92	2.48	164.16
C-203-A	28	2	17.25	0.45	574.91	0.78	279.57	3.21	136.74
C-203-B	28	2	17.32	0.44	578.06	0.78	282.20	3.96	158.52
C-303-A	7	3	17.42	0.45	599.67	0.78	274.92	2.66	157.19
C-303-B	7	3	17.39	0.45	586.63	0.78	275.94	4.52	154.69
C-302-A	14	3	17.38	0.81	490.81	1.22	313.05	4.14	85.99
C-302-B	14	3	17.48	0.85	506.87	1.05	274.54	2.84	92.80
C-402-A	7	4	17.59	0.45	602.30	0.78	274.75	2.66	149.16
C-402-B	7	4	17.66	0.49	592.08	0.78	283.25	2.84	143.98
C-401-A	14	4	17.64	0.28	672.77	0.61	283.98	2.12	225.34
C-401-B	14	4	17.70	0.27	683.38	0.61	286.99	2.12	228.47

Note: 1 KPa = 0.145 psi; 1 KN/m^3 = 6.36 pcf

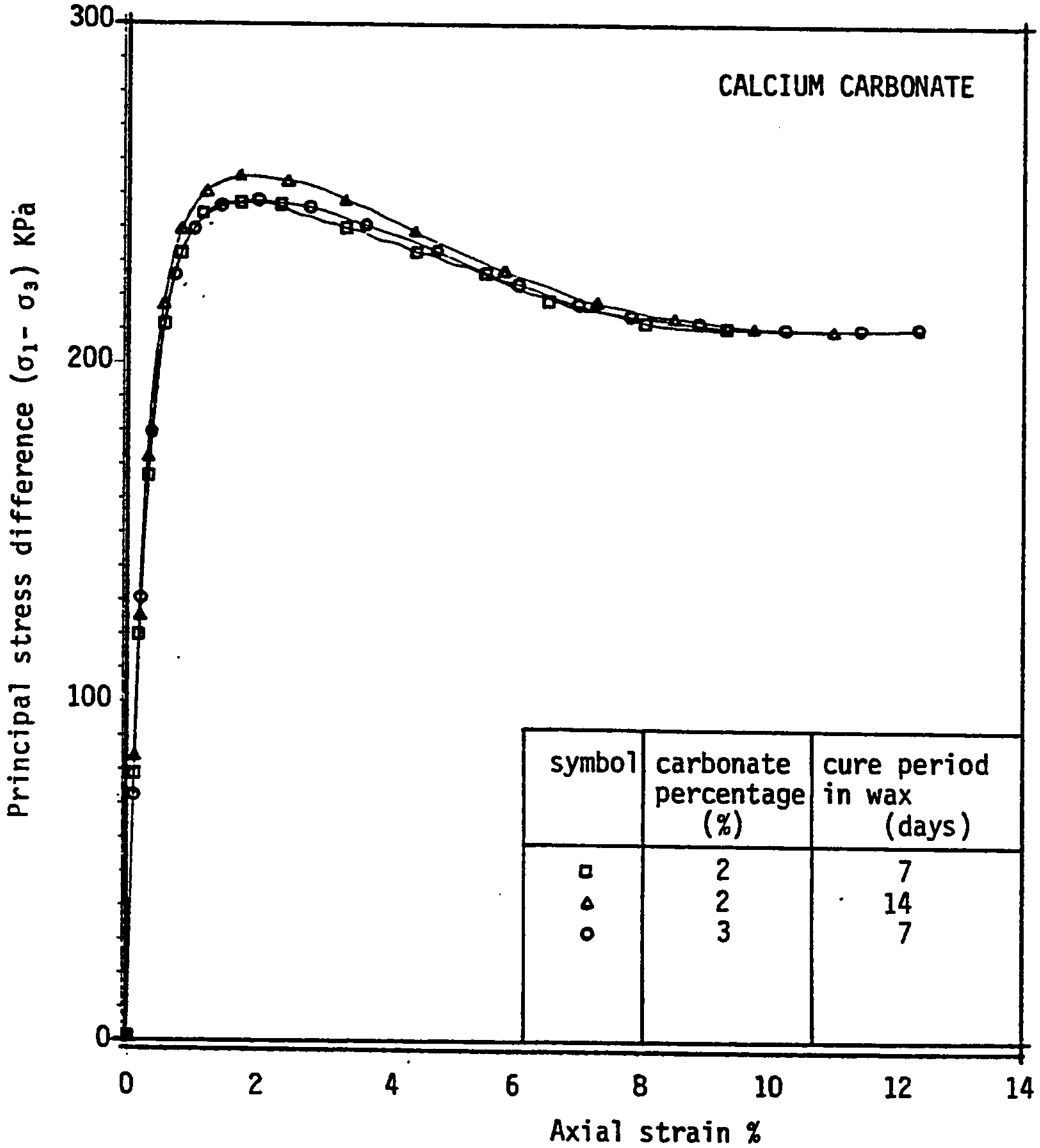


Fig. 4.34: Unsaturated undrained static triaxial stress-strain curves for sand mixed with different percentages of calcium carbonate, cured in wax for varying periods and tested at a confining pressure of 69 KPa.

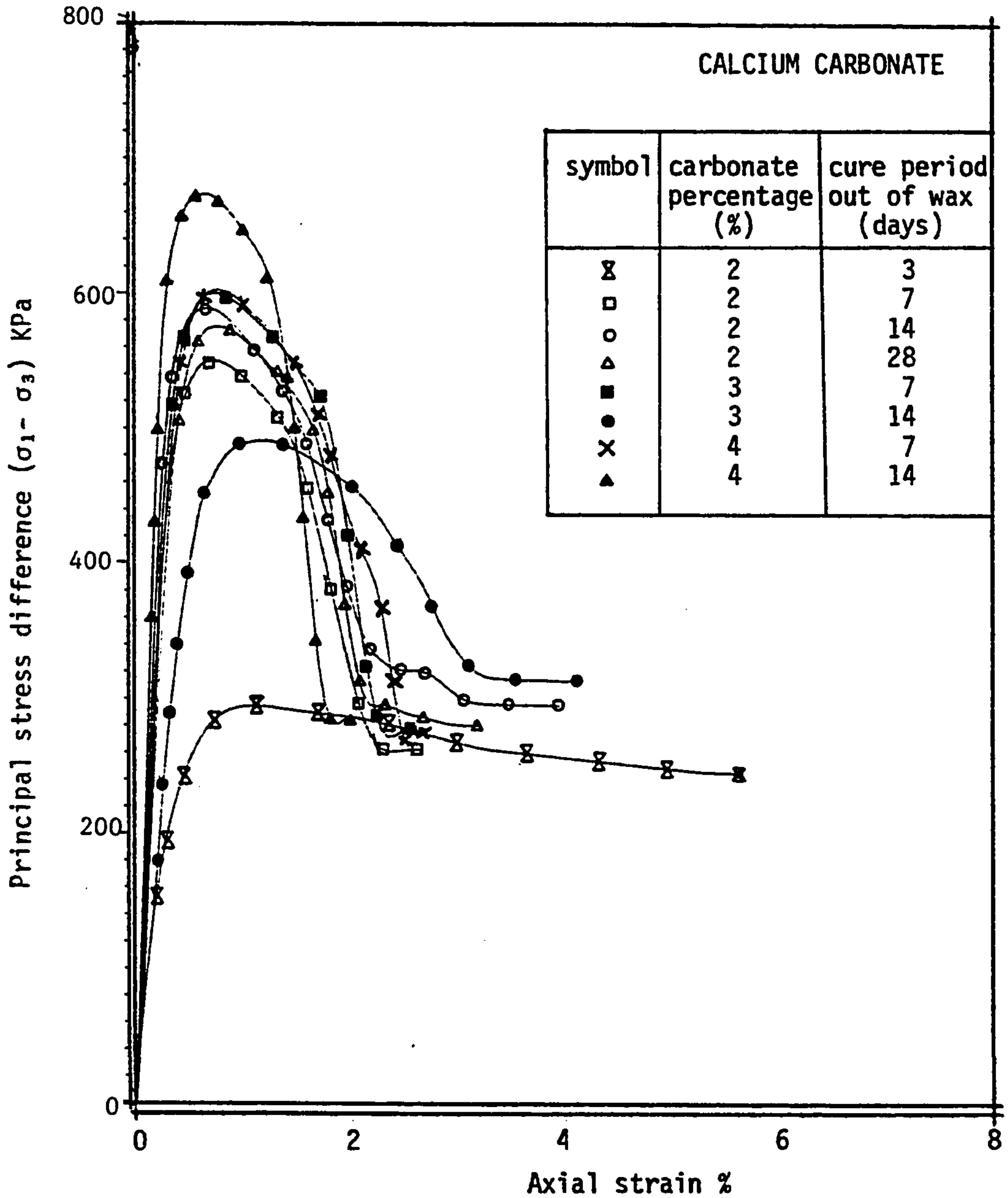


Fig. 4.35: Unsaturated undrained static triaxial stress-strain curves for sand mixed with different percentages of calcium carbonate, cured in wax for 7 days and out of wax for varying periods and tested at a confining pressure of 69 KPa.

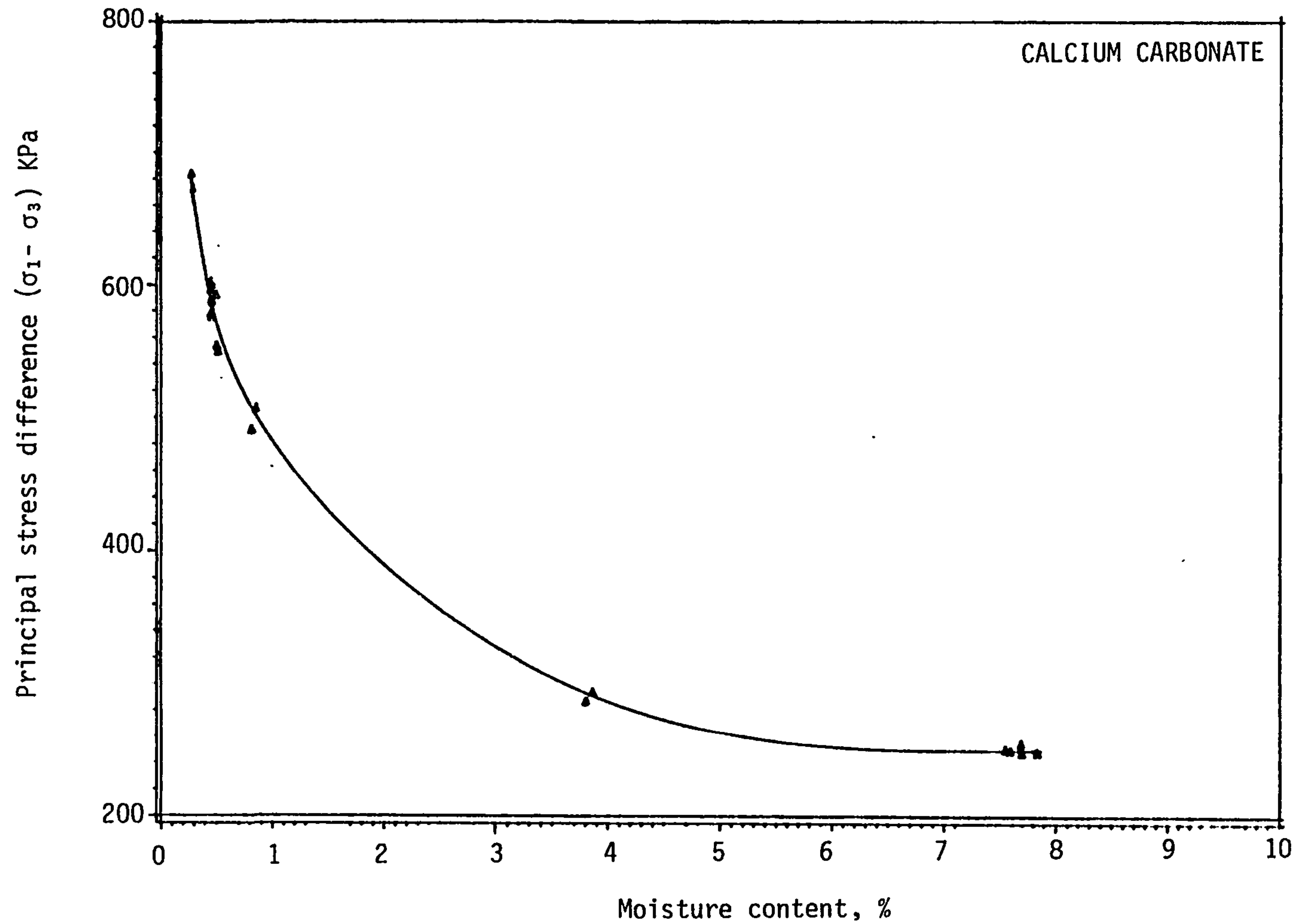


Fig. 4.36: Variation of peak strength with final moisture content for sand mixed with different percentages of calcium carbonate, cured for varying periods and tested at a confining pressure of 69 KPa.

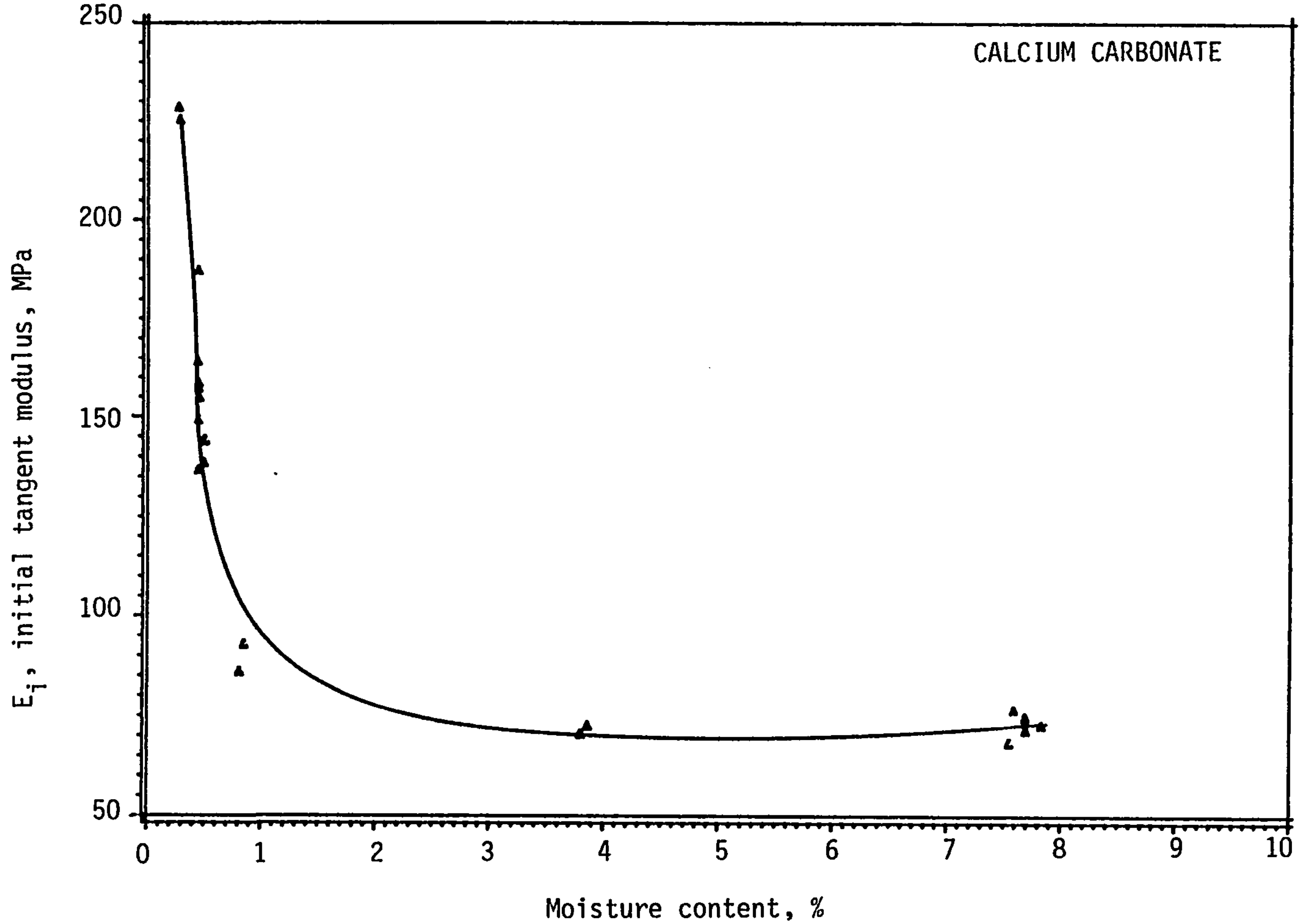


Fig. 4.37: Variation of initial tangent modulus with final moisture content for sand mixed with different percentages of calcium carbonate cured for varying periods and tested at a confining pressure of 69 KPa.

percentages of similar additives such as lime, or use those additives with soils which contain high percentage of fines. As can be seen from the stress-strain curves in Fig. 4.34, peak strength, residual strength and deformation modulus values were not affected by the two main variables namely: percent carbonate and cure time. Results presented in Fig. 4.34 shows the same stress strain curve for all samples cured in wax, irrespective of whether 2% or 3% calcium carbonate was used or whether samples were cured in wax for 7 or for 14 days. This indicates that cementation process due to presence of calcium carbonate had not developed between the sand grains under test conditions selected, because with the presence of water, the calcium carbonates were softened, weakened and therefor can not hold the sand grains together. Ductile failure type with the absence of distinct failure surface was observed. The failure mode was primarily by expansion and bulging as shown in plate 4.3.

Mixing procedure, preparation method, moisture content and sand characteristics, each has its own effect on the development of cementation. The effect of each alone is not yet known simply because with such mixing procedure and low percentage of calcium carbonate no information is available. To support the argument of the absence of cementation development, the author prefers to compare the obtained results with some of the documented results on a similar cementing material such as lime.

Lime stabilization has been in use for long time and a lot is known about it. To study the effect of different parameters such as:

mixing procedure, sand characteristics and cure conditions on performance of calcium carbonate specimens we may compare it with lime since lime is chemically the closest type to calcium carbonate. It is conceivable that the factors affecting performance and characteristics of lime stabilized soils may also be appropriate in the case of calcium carbonate dispersed in sand. In the case of my calcium carbonate study, neither cure time nor carbonate percentages had much effect on the strength and stress-strain behavior of samples mixed with calcium carbonate and cured in wax. This may be attributed to several factors such as; type of sand, the low percent of carbonate used, moisture content, lack of fines and probably most important of all is the method of cure. The sand used during this laboratory investigation is uniform material lacking fines i.e. the sand used contained less than 2% passing #200 sieve, and most of it is nonclay fraction. When considering lime stabilization clay fraction of a soil is a major source of silica or alumina or both for the development of pozzolanic reaction. Pozzolanic reaction occurs between lime and the soil silica or alumina or both to form various types of cementing agent. If this pozzolanic reaction is inhibited, high mixture strength can not be developed [47], and due to the pozzolanic properties of the clay, lime will liberate and combine with the clay to produce extra cementation [35]. Reactivity of soil is at least partly caused by the higher clay content [46], and not all soils exhibit improved strength, stress strain and fatigue characteristics when mixed with lime. If the soil is non-reactive, extensive pozzolanic strength development will not be achieved regardless of lime type, lime percentage or curing conditions [42]. Marked strength increases are not always obtained by the addition of 3% to 7% by weight of lime [46]. The addition of lime to fine-grained soils causes flocculation and agglomeration of the clay fraction and may generally increase the strength, and that is why most researchers agree that hydrated lime or quicklime should be used to stabilize cohesive soils and they require minimum percentage of clay fraction [3, 42, 44]. This may as well be applicable to calcium carbonate but that needs to be verified in the laboratory.

In my laboratory work, water content during compaction of carbonate specimens in the laboratory may have not been enough for calcium diffusion. The literature reveals that for a given lime content the soil strength may be improved by increasing the water content, and addition of water after compaction can usually improve strength of soils compacted at or below optimum moisture content [33]. This could be one of the reasons why cementation was not apparent on my samples.

The work done by Akili and Torrance [1] on a clean uniform fine sand shows that samples cemented by chemical precipitation of calcium carbonate exhibited increased penetration resistance. They concluded that the higher the amount of precipitated calcium carbonate the higher the resistance to penetration. Their method of adding the cementing agent is completely different than the method followed in this thesis. In their work the air-dry sand was placed in perspex cylinder by the pluviation method up to a certain height. A mixture of sand and the powdered sodium carbonate (Na_2Co_3) was pluviated on top of the sand in the cylinder to the same relative density for a certain thickness. Concentrated solution of calcium chloride ($CaCl_3$) was introduced into the cylinder from the bottom and allowed to flow slowly up through the sample. When the solution reached the zone in which the sodium carbonate was present reaction occurred and calcium carbonate ($CaCo_3$) was formed. This chemical precipitation of $CaCo_3$ provides the cementation bonds between the sand grains and increases the penetration resistance.

Another method of adding the cementing agent was tried by Akili and Torrance [1] in which a saturated calcium carbonate solution was introduced into the pluviated sand and the sample was allowed to dry up under 100 watt light bulb 3 cm above the surface of the sample. They concluded that no visible carbonate was generated at any point in the system in a 3 month period.

Poulos [30] tried to promote artificial cementation of the carbonate sand by leaving some samples in an odometer in the presence of a super-saturated solution of calcium carbonate for a period of 10 week under a stress of 248 KPa·and he concluded that no visible signs of cementation were apparent upon examination. He increased the stress by 310 KPa for some samples, they were left for a further 6-8 weeks. Samples, show similar behavior and properties to the untreated samples and no firm conclusions can be drown from the above results, no cementation appears to be developed in a static calcium carbonate in the laboratory environment [30]. This is the case with our specimens cured in wax in the laboratory.

In my thesis work, samples were prepared with 2%, 3% and 4% calcium carbonate by weight of sand and allowed to cure either in wax for 7 and 14 days (category I) or in wax for 7 days followed by out of wax for varying periods (category II). Those samples that belonged to category II exhibited appreciable difference in their strength values and general stress-strain behavior. In all specimens of category II, it was observed that the lower the moisture content the higher the peak strength values as well as the initial tangent modulus values regardless of cure time or percent carbonate. This indicate that the drying process is essential for cementation development. The stress-strain curves shown in Fig. 4.35 show substantially higher peak strength values than those samples cured in wax (Fig. 4.34). The samples cured out of wax (category II) exhibited a brittle failure mode and a unique well defined shear failure surface similar to the one shown in plate 4.1. The peak strength values are plotted in Fig. 4.36 against moisture content at testing time for all carbonate samples including those cured in wax. The dryer the sample at testing the higher the strength. The initial tangent modulus values are plotted in Fig. 4.37 against moisture content at testing for all carbonate specimens and the dryer the sample the higher the modulus value.

The strength exhibited by those samples which were cured in wax for 7 days and out of wax for varying periods (category II) signifies that cementation development appears related to the drying of the carbonate samples. Thus drying is essential to the development of cementation bonds between sand grains. The dryer the specimen the stronger the bond. This behavior of gaining strength with the drying process is observed in the Sabkha's upper crust, where it is very strong when dry but soft and weak upon wetting.

5. SUMMARY AND CONCLUSIONS

5.1 Summary

This thesis describes a laboratory investigation on behavior of laboratory prepared cemented sand specimens under static loading. The selected dune sand used in the preparation of artificially cemented sand specimens, was mixed with a selected amount of a cementing agent by hand in a dry state. The dry mix was then poured into a mechanical mixing bowl and a predetermined amount of distilled water was added. The mixing process was carried for about 5 min., using a mechanical mixer. Samples were prepared and allowed to cure prior to testing. Two types of cure were tried; curing in which moisture content was kept almost constant by wrapping the the specimens with plastic sheets and immersing them in a molten wax. This is referred to as "in wax cure". In the other type, samples were left in the molds without any coating and therefore moisture content was reduced, this is referred to as "out of wax cure".

The static triaxial apparatus was utilized for testing all samples. Two types of testing were performed; the unsaturated undrained static triaxial tests and, the drained static triaxial tests. In the drained test samples were saturated using carbon dioxide and back pressure. The effect of several parameters on the strength and stress-strain characteristics of the cemented sand specimens, where portland cement being the cementing agent, were studied. These parameters are: cure type, cure time, confining pressure, effect of degree of saturation, density, cement content and the effect of reconstitution. calcium carbonate was tried as another cementing agent. Different cure types, different cure times and different carbonate contents were tried, and unsaturated undrained static triaxial tests were performed on all calcium carbonate samples.

5.2 Conclusions

The most important conclusions of this study are:

1. The addition of a small amount of portland cement to sands results in cementation bonds which has a marked effect on stress-strain and strength of tested samples. For example, the addition of 2% and 4% portland cement to sand samples, tested after 14 days in wax, resulted in ultimate strength value of 530 and 960 KPa respectively. These values are approximately twice and three and half times the peak value exhibited by an uncemented sand sample (reconstituted samples) cured and tested in the same manner and for the same cure period. Additionally, the effect of cementation manifests itself in a cohesion intercept, where, as an example, a 2% cement results in a cohesion intercept of 60.34 KPa as compared to zero cohesion prior to cementation bond development of the cohesionless material.

2. Test results have shown that sample's strength increases with increasing cure period, confining pressure, percent cement in the mix and sample's density. For example, samples with 2% portland cement and cured in wax for 28 days have exhibited a peak strength value of at least 560 KPa compared with not more than 312 KPa for a similar specimen tested directly after compaction where the effect of cementation development had not materialized. Samples with 2% portland cement and tested at a confining pressure of 69 KPa have a peak strength of not more than 340 KPa, while those prepared and tested at the same conditions but at a confinement of 276 KPa have exhibited peak strength of at least 1330 KPa. Samples cemented with 1% portland cement and tested after 14 days result in peak strength value of not more than 375 KPa, while samples with 4% cement result in peak strength values of not less than 960 KPa. Density of 17.60 KN/m^3 for samples with 2% portland cement result in peak strength of more than 600 KPa, while samples with density of 16.15 KN/m^3 result in peak strength of less than 385 KPa.

3. The addition of 2% cement results in a cohesion intercept of 60.34 KPa and an angle of internal friction of 41.20° after 14 days of in wax cure, while uncemented sands have no cohesion intercept and have an angle of internal friction comparable to that of cemented sands.

4. During the process of cure the dryer the sample the higher its strength up to a limit, after which no more increase in the strength is observed. Samples cured out of wax and tested after 28 days at a moisture content of 0.84% have peak strength values of at least 920 KPa compared to 570 KPa for samples cured in wax for 28 days but tested at a moisture content of 7.4%.

5. The residual strength of a cemented sand is not affected by any of the parameters noted above, except by confining pressure and molding density.

6. The rate of volumetric change increases as the confining pressure decreases. However, the final volumetric change is the same regardless of the confining pressure level.

7. Saturation of dry specimens reduces the strength and increases the final volumetric strain. Tests on samples cured out of wax and tested in drained condition result in peak strength values of 590 KPa or less, while the peak value of similar specimens tested in unsaturated undrained mode is more than 680 KPa.

8. Samples prepared by mechanical degradation of originally cemented sand samples and referred to here as reconstituted samples, did not exhibit any gain in strength

with time upon cure. This is because the portland cement originally present had already hydrated. It's role in the reconstituted samples is primarily that of a filler.

9. No sign of cementation was observed in samples mixed with calcium carbonate and allowed to cure in wax, because full development of cementation bond for this category may require longer period than portland cement cementation. However cementation appears present for samples cured out of wax. It was observed that the dryer the specimen the stronger it is regardless of the percentage of carbonate or cure time. Peak strength values for samples tested at moisture content of 0.44 % are not less than 588 KPa, while it is not more than 250 KPa for similar samples but tested at a moisture content of 7.70 %, which indicates that cementation bonds have developed as a function of drying process which depends on the cure period (out of wax).

10. Failure mode is a function of moisture content as well as sample's stiffness. Brittle type failure with distinct failure surface occurs with dryer samples and samples with higher cement content (stiff samples); where as more than one failure surface occur when the moisture content is high. When no cementation effects

are present, test samples bulge out and with no apparent failure surfaces even at high axial strain levels.

5.3 Recommendations

It is recommended that this investigation be extended in the future along the lines stated below:

1. A predictive formula for the strength of cemented soils is needed which will consider all different variables. This can be done by running a comprehensive testing program where all parameters are considered.

2. The effect of saturation on dry samples need to be investigated for samples with different moisture contents (i.e. different cure period out of wax).

3. There need to be a preparation procedure where a uniform specimens density throughout the specimen's height is achieved.

4. Samples mixed with calcium carbonate need to be investigated properly in terms of mixing procedure and cure period. It may require longer period in wax to develop cementation and if cementation is achieved then the effect of different parameters tried with portland cement need to be tried with calcium carbonate.

Repeated wetting and drying on calcium carbonate samples may produce cementation.

5. Cementation bonds (type and characteristics) need to be studied using the microscope, this will indicate the effect of reconstitution and disturbance on those specimens.

6. Dynamic tests on cemented sand specimens need to be carried out.

7. The effect of temperature during cure period need to be investigated, since the hydration of portland cement depends on the cure temperature.

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APPENDIX A

STATIC TRIAXIAL TEST'S DATA AND CALCULATIONS

This program is used to analyse the data obtained from the unsaturated undrained static triaxial tests.

```
$JOB
      REAL LO,LD,LDR,DD,AO,SIG3,VO,LOAD,DEVIAT
      DIMENSION ST(200),LOAD (200),LD(200),DD(200),AC(200),DEVIAT(200),Q
     C(200),P(200),LDR(200)
      WRITE (6,81)
      WRITE (6,10)
 10   FORMAT('1',/,24X,' ** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION T
     CEST **'/)
      WRITE (6,17)
 17   FORMAT(' ',24X,'** SAMPLE C-201-A ,TESTED ON 15/04/1984 @ 11:30 AM
     C **')
      WRITE (6,20)
 20   FORMAT(' ',24X,'** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE S
     CAND')
      WRITE (6,22)
 22   FORMAT(' ',27X,' + 2 PARTS CALCIUM CARBONATE + 8 PARTS WATER **')
      WRITE (6,30)
 30   FORMAT(' ',18X,'CONFINING PRESSURE = 69 KPA',11X,'DRY DENSITY = 17
     C.39 KN/M**3')
      WRITE (6,32)
 32   FORMAT(' ',15X,'WATER CONTENT AT TESTING=7.694% ',13X,'CURE PERIOD
     C= 7 DAYS IN WAX')
      WRITE (6,34)
 34   FORMAT(' ',15X,'SAMPLE LENGTH= 14.71 CM',24X,'SAMPLE AREA= 41.12 C
     CM**2')
      WRITE (6,60)
      PRINT 40
 40   FORMAT (' ',16X,'DDR',9X,'LDR',7X,'CS',9X,'LOAD',8X,'DS',10X,'Q',
     C10X,'P')
      PRINT 51
 51   FORMAT(' ',16X,'DIV.',8X,'DIV.',7X,'%',10X,'N',10X,'KPA',8X,'KPA'
     C,8X,'KPA')
      WRITE (6,60)
 60   FORMAT(' ',13X,'--------------------------------------------------
     C-------------------------')
      READ , N , AO , LO , SIG3
      DO 80 I=1,N
      READ , DD(I) , LD(I)
      ST(I) = DD(I) * 0.001*100 /(LO-DD(I)*0.001)
      VO    = AO * LO
      AC(I) = 2.54*2.54*VO/(10000*(LO-DD(I)*0.001))
      LDR(I)=1.00*LD(I)
      LOAD(I) = LDR(I) * 1.08*4.448
      DEVIAT(I) = LOAD(I) / (1000*AC(I))
      Q(I) = DEVIAT(I)/2
      P(I) = (DEVIAT(I)+2*6.9*SIG3)/2
      PRINT 70 , DD(I) , LDR(I), ST(I) , LOAD(I),DEVIAT(I),Q(I),P(I)
 70   FORMAT (15X,F6.2,7X,F5.1,5X,F5.2,5X,F7.2,5X,F6.2,5X,F6.2,5X,F6.2)
 80   CONTINUE
      WRITE(6,81)
 81   FORMAT('1')
      STOP
      END
$ENTRY
```

This program is used to analyse the data obtained from the drained static triaxial tests.

```
$JOB
      REAL LO,LD,LDR,DD,AO,SIG3,VO,LOAD,DEVIAT,CVC,BR,LCO
      DIMENSION ST(200),LOAD (200),LD(200),DD(200),AC(200),DEVIAT(200),Q
     C(200),P(200),V(200),VC(200),BR(200),LDR(200)
      WRITE (6,81)
      WRITE (6,10)
10    FORMAT('1',/,31X,' ** DRAINED TRIAXIAL COMPRESION TEST **'/)
      WRITE (6,17)
17    FORMAT(' ',25X,'** SAMPLE S-217-A ,TESTED ON 21/04/1984 @ 10:00 AM
     C **')
      WRITE (6,20)
20    FORMAT(' ',25X,'** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE S
     CAND')
      WRITE (6,22)
22    FORMAT(' ',25X,' + 2 PARTS PORTLAND CEMENT TYPE(V) + 8 PARTS WATER
     C **')
      WRITE (6,30)
30    FORMAT(' ',19X,'CONFINING PRESSURE = 69 KPA', 12X,'DRY DENSITY = 1
     C7.19 KN/M**3')
      WRITE (6,32)
32    FORMAT(' ',13X,'WATER CONTENT AT TESTING = 20.389 % ',10X,'CURE PE
     CRIOD = 14 DAYS OUT OF WAX')
      WRITE (6,34)
34    FORMAT(' ',13X,'DGREE OF SATURATION =97.9%',3X,'SAMPLE LENGTH= 14.
     C72CM',3X,'SAMPLE AREA= 41.45 CM**2')
      WRITE (6,60)
      PRINT 40
40    FORMAT (' ',16X,'DDR',5X,'LDR',6X,'BR',6X,'CS',6X,'VS',6X,'LOAD'
     C,7X,'DS',7X,'Q',8X,'P')
      PRINT 51
51    FORMAT(' ',16X,'DIV.',4X,'DIV.',5X,'ML',6X,'%',7X,'%',8X,'N'
     C,8X,'KPA',6X,'KPA',6X,'KPA')
      WRITE (6,60)
60    FORMAT(' ',13X,'-----------------------------------------------
     C----------------------------')
      READ , N , AO , LO , SIG3 , CVC
C     CVC SHOUD BE -VE IF WATER IS EXPELLED OUT FROM SAMPLE.
      DO 80 I=1,N
      READ , DD(I) , LD(I) , BR(I)
      VO     = AO * LO
      CST = CVC / (3*VO*2.54**3)
      VCO =  VO* 2.54**3 + CVC
      LCO = 2.54*LO *(1+CST)
      VC(I) = (BR(I)-BR(1))*100/VCO
      ST(I) = 2.54*DD(I) * 0.001*100 /(LCO-DD(I)*0.001*2.54)
      ACO = VCO / LCO
      AC(I) = ACO /10000 * ((1+0.01*VC(I)) / (1-0.01*ST(I)))
      LDR(I) = LD(I)* 1.00
      LOAD(I) = LDR(I) * 1.08*4.448
      DEVIAT(I) = LOAD(I) /(1000* AC(I))
      Q(I) = DEVIAT(I)/2
      P(I) = (DEVIAT(I)+2*6.9*SIG3)/2
      PRINT 70 , DD(I) , LDR(I), BR(I), ST(I) , VC(I) , LOAD(I),DEVIAT(I)
     C), Q(I),P(I)
70    FORMAT (15X,F6.2,3X,F5.1,3X,F5.2,3X,F5.2,3X,F5.2,3X,F7.2,3X,F6.2,
     C3X,F6.2,3X,F6.2)
80    CONTINUE
      WRITE(6,81)
81    FORMAT('1')
      STOP
      END

$ENTRY
```

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE S-224-A ,TESTED ON 26/05/1984 @ 5:00 PM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 2 PARTS PORTLAND CEMENT TYPE(V) + 8 PARTS WATER **
CONFINING PRESSURE = 69 KPA DRY DENSITY = 17.15 KN/M**3
WATER CONTENT AT TESTING = 7.817 % CURE PERIOD = 0 DAYS IN WAX
SAMPLE LENGTH= 14.75 CM SAMPLE AREA= 41.48 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	69.00
5.00	50.0	0.09	240.19	57.86	28.93	97.93
10.00	88.0	0.17	422.74	101.75	50.87	119.87
15.00	120.0	0.26	576.46	138.63	69.31	138.31
20.00	147.0	0.35	706.16	169.67	84.84	153.84
25.00	172.0	0.43	826.26	198.36	99.18	168.18
30.00	191.0	0.52	917.53	220.08	110.04	179.04
35.00	207.0	0.61	994.39	238.31	119.16	188.16
40.00	219.0	0.69	1052.04	251.91	125.95	194.95
45.00	229.0	0.78	1100.08	263.18	131.59	200.59
50.00	236.5	0.87	1136.11	271.57	135.78	204.78
55.00	242.0	0.96	1162.53	277.64	138.82	207.82
60.00	247.0	1.04	1186.55	283.13	141.56	210.56
70.00	254.0	1.22	1220.17	290.65	145.32	214.32
80.00	258.5	1.40	1241.79	295.28	147.64	216.64
90.00	262.0	1.57	1258.61	298.76	149.38	218.38
100.00	264.0	1.75	1268.21	300.51	150.26	219.26
110.00	266.0	1.93	1277.82	302.26	151.13	220.13
120.00	267.0	2.11	1282.62	302.86	151.43	220.43
130.00	267.5	2.29	1285.03	302.89	151.45	220.45
140.00	267.5	2.47	1285.03	302.36	151.18	220.18
150.00	268.0	2.65	1287.43	302.39	151.20	220.20
160.00	267.5	2.83	1285.03	301.29	150.65	219.65
170.00	267.0	3.02	1282.62	300.20	150.10	219.10
180.00	266.5	3.20	1280.22	299.10	149.55	218.55
190.00	266.0	3.38	1277.82	298.01	149.01	218.01
200.00	265.0	3.57	1273.02	296.36	148.18	217.18
210.00	264.0	3.75	1268.21	294.72	147.36	216.36
220.00	263.0	3.94	1263.41	293.08	146.54	215.54
230.00	262.0	4.12	1258.61	291.44	145.72	214.72
240.00	261.0	4.31	1253.80	289.81	144.90	213.90
250.00	260.0	4.50	1249.00	288.18	144.09	213.09
260.00	259.0	4.69	1244.19	286.55	143.28	212.28
270.00	257.5	4.88	1236.99	284.38	142.19	211.19
280.00	256.5	5.07	1232.18	282.77	141.38	210.38
290.00	255.0	5.26	1224.98	280.60	140.30	209.30
300.00	254.0	5.45	1220.17	279.00	139.50	208.50
310.00	252.5	5.64	1212.97	276.85	138.42	207.42
320.00	252.0	5.83	1210.57	275.79	137.90	206.90
340.00	249.0	6.22	1196.16	271.52	135.76	204.76
360.00	247.5	6.61	1188.95	268.90	134.45	203.45
380.00	246.0	7.00	1181.74	266.29	133.14	202.14
400.00	245.0	7.40	1176.94	264.23	132.11	201.11
420.00	244.0	7.79	1172.14	262.17	131.09	200.09
440.00	243.0	8.20	1167.33	260.13	130.07	199.06
480.00	242.0	9.01	1162.53	257.13	128.56	197.56
520.00	241.5	9.83	1160.13	254.67	127.34	196.34
540.00	241.5	10.25	1160.13	253.71	126.85	195.85
560.00	242.0	10.67	1162.53	253.27	126.63	195.63
590.00	242.5	11.31	1164.93	252.34	126.17	195.17

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE S-224-B ,TESTED ON 26/05/1984 @ 6:00 PM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 2 PARTS PORTLAND CEMENT TYPE(V) + 8 PARTS WATER **
CONFINING PRESSURE = 69 KPA DRY DENSITY = 17.16 KN/M**3
WATER CONTENT AT TESTING = 7.800 % CURE PERIOD = 0 DAYS IN WAX
SAMPLE LENGTH= 14.73 CM SAMPLE AREA= 41.58 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	69.00
5.00	57.0	0.09	273.82	65.95	32.98	101.98
10.00	100.0	0.17	480.38	115.61	57.80	126.80
15.00	130.0	0.26	624.50	150.16	75.08	144.08
20.00	155.0	0.35	744.59	178.88	89.44	158.44
25.00	179.0	0.43	859.89	206.40	103.20	172.20
30.00	198.0	0.52	951.16	228.11	114.06	183.06
35.00	214.0	0.61	1028.02	246.33	123.17	192.17
40.00	226.0	0.69	1085.67	259.92	129.96	198.96
45.00	236.0	0.78	1133.71	271.19	135.59	204.59
50.00	244.0	0.87	1172.14	280.13	140.07	209.07
60.00	254.5	1.05	1222.58	291.68	145.84	214.84
70.00	261.0	1.22	1253.80	298.61	149.30	218.30
80.00	266.0	1.40	1277.82	303.80	151.90	220.90
90.00	270.0	1.58	1297.04	307.83	153.91	222.91
100.00	272.0	1.75	1306.64	309.57	154.78	223.78
110.00	274.0	1.93	1316.25	311.29	155.65	224.65
120.00	275.0	2.11	1321.05	311.88	155.94	224.94
130.00	275.5	2.29	1323.46	311.90	155.95	224.95
140.00	276.0	2.47	1325.86	311.91	155.96	224.96
150.00	276.0	2.66	1325.86	311.36	155.68	224.68
160.00	276.0	2.84	1325.86	310.81	155.41	224.41
170.00	276.0	3.02	1325.86	310.26	155.13	224.13
180.00	275.5	3.20	1323.46	309.15	154.57	223.57
190.00	274.5	3.39	1318.65	307.48	153.74	222.74
200.00	274.0	3.57	1316.25	306.37	153.19	222.19
210.00	273.0	3.76	1311.45	304.71	152.35	221.35
220.00	272.0	3.94	1306.64	303.05	151.52	220.52
230.00	271.0	4.13	1301.84	301.39	150.70	219.70
240.00	270.0	4.32	1297.04	299.74	149.87	218.87
250.00	269.0	4.50	1292.23	298.09	149.05	218.05
260.00	268.0	4.69	1287.43	296.45	148.23	217.23
270.00	266.5	4.88	1280.22	294.26	147.13	216.13
280.00	264.5	5.07	1270.62	291.52	145.76	214.76
290.00	263.0	5.26	1263.41	289.34	144.67	213.67
300.00	261.0	5.45	1253.80	286.62	143.31	212.31
310.00	259.0	5.65	1244.19	283.91	141.95	210.95
320.00	257.0	5.84	1234.59	281.20	140.60	209.60
340.00	254.0	6.23	1220.17	276.91	138.45	207.45
360.00	251.0	6.62	1205.76	272.63	136.32	205.32
380.00	249.0	7.01	1196.16	269.47	134.73	203.73
400.00	248.0	7.41	1191.35	267.39	133.70	202.70
420.00	247.5	7.81	1188.95	265.87	132.93	201.93
440.00	247.0	8.21	1186.55	264.34	132.17	201.17
460.00	247.5	8.61	1188.95	263.89	131.95	200.94
480.00	248.0	9.02	1191.35	263.43	131.72	200.72
500.00	248.5	9.43	1193.75	262.97	131.49	200.49

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE S-207-A ,TESTED ON 28/02/1984 @ 2:00 PM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 2 PARTS PORTLAND CEMENT TYPE(V) + 8 PARTS WATER **
CONFINING PRESSURE = 69 KPA DRY DENSITY = 17.20 KN/M**3
WATER CONTENT AT TESTING = 7.643 % CURE PERIOD = 1 DAY IN WAX
SAMPLE LENGTH= 14.71 CM SAMPLE AREA= 41.38 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	69.00
5.00	87.0	0.09	417.93	100.90	50.45	119.45
10.00	148.0	0.17	710.97	171.50	85.75	154.75
15.00	192.0	0.26	922.34	222.30	111.15	180.15
20.00	221.0	0.35	1061.65	255.66	127.83	196.83
25.00	246.0	0.43	1181.74	284.33	142.16	211.16
30.00	261.0	0.52	1253.80	301.41	150.70	219.70
40.00	286.5	0.70	1376.30	330.28	165.14	234.14
50.00	299.5	0.87	1438.75	344.66	172.33	241.33
55.00	303.0	0.96	1455.56	348.39	174.19	243.19
60.00	306.0	1.05	1469.97	351.53	175.77	244.77
70.00	309.5	1.22	1486.79	354.93	177.47	246.47
80.00	311.5	1.40	1496.40	356.60	178.30	247.30
90.00	311.5	1.58	1496.40	355.98	177.99	246.99
100.00	311.0	1.76	1493.99	354.78	177.39	246.39
110.00	309.5	1.94	1486.79	352.45	176.23	245.23
120.00	307.5	2.12	1477.18	349.56	174.78	243.78
130.00	305.0	2.30	1465.17	346.10	173.05	242.05
140.00	302.5	2.48	1453.16	342.66	171.33	240.33
150.00	299.5	2.66	1438.75	338.66	169.33	238.33
160.00	297.0	2.84	1426.74	335.24	167.62	236.62
170.00	293.5	3.02	1409.93	330.70	165.35	234.35
180.00	290.5	3.21	1395.51	326.74	163.37	232.37
190.00	287.0	3.39	1378.70	322.23	161.11	230.11
200.00	284.0	3.58	1364.29	318.29	159.15	228.14
210.00	280.5	3.76	1347.48	313.81	156.90	225.90
220.00	277.0	3.95	1330.66	309.33	154.67	223.67
230.00	273.5	4.13	1313.85	304.88	152.44	221.44
240.00	270.0	4.32	1297.04	300.44	150.22	219.22
250.00	266.5	4.51	1280.22	296.01	148.00	217.00
260.00	262.5	4.70	1261.01	291.04	145.52	214.52
270.00	258.5	4.89	1241.79	286.08	143.04	212.04
280.00	254.5	5.08	1222.58	281.15	140.57	209.57
290.00	250.0	5.27	1200.96	275.68	137.84	206.84
300.00	246.0	5.46	1181.74	270.77	135.39	204.39
310.00	241.0	5.65	1157.72	264.78	132.39	201.39
320.00	236.5	5.85	1136.11	259.37	129.68	198.68
340.00	227.0	6.24	1090.47	248.04	124.02	193.02
360.00	218.5	6.63	1049.64	237.88	118.94	187.94
380.00	211.0	7.02	1013.61	228.86	114.43	183.43
400.00	205.5	7.42	987.19	222.08	111.04	180.04
420.00	203.0	7.82	975.18	218.56	109.28	178.28
440.00	202.0	8.22	970.38	216.67	108.34	177.34

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE S-208-A ,TESTED ON 03/03/1984 @ 4:00 PM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 2 PARTS PORTLAND CEMENT TYPE(V) + 8 PARTS WATER **
CONFINING PRESSURE = 69 KPA DRY DENSITY = 17.17 KN/M**3
WATER CONTENT AT TESTING = 7.304 % CURE PERIOD = 3 DAYS IN WAX
SAMPLE LENGTH= 14.72 CM SAMPLE AREA= 41.35 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	69.00
5.00	142.0	0.09	682.15	164.83	82.42	151.42
10.00	226.0	0.17	1085.67	262.11	131.05	200.05
15.00	276.0	0.26	1325.86	319.82	159.91	228.91
20.00	304.0	0.35	1460.37	351.96	175.98	244.98
25.00	323.0	0.43	1551.64	373.64	186.82	255.82
30.00	338.5	0.52	1626.10	391.23	195.61	264.61
35.00	350.0	0.61	1681.34	404.17	202.08	271.08
40.00	356.0	0.69	1710.17	410.74	205.37	274.37
45.00	363.0	0.78	1743.79	418.45	209.23	278.23
50.00	367.5	0.87	1765.41	423.27	211.64	280.64
55.00	371.0	0.96	1782.22	426.93	213.47	282.47
60.00	373.5	1.05	1794.23	429.43	214.72	283.72
70.00	377.0	1.22	1811.05	432.70	216.35	285.35
80.00	379.5	1.40	1823.06	434.81	217.41	286.41
90.00	381.0	1.58	1830.26	435.77	217.88	286.88
100.00	382.0	1.76	1835.07	436.14	218.07	287.07
110.00	382.0	1.93	1835.07	435.38	217.69	286.69
120.00	381.5	2.11	1832.66	434.04	217.02	286.02
130.00	380.5	2.29	1827.86	432.14	216.07	285.07
140.00	378.5	2.47	1818.25	429.11	214.56	283.56
150.00	376.5	2.66	1808.65	426.09	213.05	282.05
160.00	374.0	2.84	1796.64	422.51	211.26	280.26
170.00	371.0	3.02	1782.22	418.38	209.19	278.19
180.00	367.5	3.20	1765.41	413.70	206.85	275.85
190.00	363.0	3.39	1743.79	407.90	203.95	272.95
200.00	358.5	3.57	1722.18	402.13	201.06	270.06
210.00	351.5	3.76	1688.55	393.57	196.79	265.79
220.00	342.5	3.94	1645.31	382.81	191.40	260.40
230.00	329.5	4.13	1582.86	367.62	183.81	252.81
240.00	318.0	4.32	1527.62	354.15	177.08	246.08
250.00	309.0	4.51	1484.39	343.51	171.75	240.75
260.00	299.5	4.70	1438.75	332.35	166.17	235.17
270.00	292.5	4.88	1405.12	323.99	162.00	231.00
280.00	287.5	5.08	1381.10	317.88	158.94	227.94
290.00	284.5	5.27	1366.69	313.99	157.00	226.00
300.00	283.0	5.46	1359.49	311.77	155.88	224.88
310.00	282.0	5.65	1354.68	310.10	155.05	224.05
320.00	281.5	5.84	1352.28	308.99	154.49	223.49
340.00	281.0	6.23	1349.88	307.31	153.66	222.66
360.00	279.0	6.62	1340.27	304.01	152.00	221.00
380.00	277.0	7.01	1330.66	300.72	150.36	219.36
400.00	266.0	7.41	1277.82	287.71	143.86	212.86
420.00	250.0	7.81	1200.96	269.40	134.70	203.70
440.00	247.0	8.21	1186.55	265.18	132.59	201.59

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE S-205-A ,TESTED ON 04/03/1984 @ 5:30 PM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 2 PARTS PORTLAND CEMENT TYPE(V) + 8 PARTS WATER **
CONFINING PRESSURE = 69 KPA   DRY DENSITY = 17.15 KN/M**3
WATER CONTENT AT TESTING = 7.482 %   CURE PERIOD = 7 DAYS IN WAX
SAMPLE LENGTH= 14.72 CM   SAMPLE AREA= 41.59 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	69.00
5.00	132.3	0.09	635.55	152.66	76.33	145.33
10.00	233.1	0.17	1119.78	268.75	134.37	203.37
15.00	299.3	0.26	1437.55	344.71	172.36	241.36
20.00	340.2	0.35	1634.27	391.55	195.77	264.77
25.00	363.3	0.43	1745.24	417.77	208.89	277.89
30.00	379.1	0.52	1820.90	435.51	217.75	286.75
35.00	390.6	0.61	1876.38	448.39	224.19	293.19
40.00	399.0	0.69	1916.73	457.63	228.82	297.82
45.00	404.8	0.78	1944.47	463.85	231.93	300.93
50.00	409.0	0.87	1964.65	468.26	234.13	303.13
55.00	412.6	0.96	1982.30	472.05	236.03	305.03
60.00	414.8	1.05	1992.39	474.04	237.02	306.02
70.00	417.4	1.22	2005.00	476.21	238.11	307.11
80.00	418.4	1.40	2010.05	476.58	238.29	307.29
90.00	418.9	1.58	2012.57	476.34	238.17	307.17
100.00	419.5	1.76	2015.09	476.10	238.05	307.05
110.00	418.9	1.93	2012.57	474.67	237.34	306.34
120.00	417.4	2.11	2005.00	472.05	236.03	305.03
130.00	415.3	2.29	1994.91	468.85	234.43	303.43
140.00	413.2	2.47	1984.83	465.66	232.83	301.83
150.00	410.6	2.66	1972.22	461.88	230.94	299.94
160.00	407.9	2.84	1959.61	458.12	229.06	298.06
170.00	404.3	3.02	1941.95	453.18	226.59	295.59
180.00	400.1	3.20	1921.78	447.68	223.84	292.84
190.00	395.8	3.39	1901.60	442.19	221.09	290.09
200.00	391.1	3.57	1878.90	436.13	218.07	287.07
210.00	385.9	3.76	1853.68	429.51	214.75	283.75
220.00	379.1	3.94	1820.90	421.16	210.58	279.58
230.00	365.9	4.13	1757.84	405.85	202.92	271.92
240.00	351.8	4.32	1689.75	389.42	194.71	263.71
250.00	338.1	4.51	1624.18	373.64	186.82	255.82
260.00	325.5	4.70	1563.65	359.06	179.53	248.53
270.00	314.5	4.88	1510.69	346.28	173.14	242.14
280.00	308.7	5.08	1482.94	339.30	169.65	238.65
290.00	305.6	5.27	1467.81	335.23	167.62	236.62
300.00	304.5	5.46	1462.77	333.47	166.74	235.74
310.00	305.6	5.65	1467.81	334.01	167.01	236.01
320.00	305.6	5.84	1467.81	333.41	166.70	235.70

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE S-211-A ,TESTED ON 24/03/1984 @ 06:00 AM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 2 PARTS PORTLAND CEMENT TYPE(V) + 8 PARTS WATER **
CONFINING PRESSURE = 69 KPA DRY DENSITY = 17.16 KN/M**3
WATER CONTENT AT TESTING = 7.337 % CURE PERIOD = 14 DAYS IN WAX
SAMPLE LENGTH= 14.64 CM SAMPLE AREA= 41.19 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	69.00
5.00	123.1	0.09	591.45	143.48	71.74	140.74
10.00	256.0	0.17	1229.59	298.02	149.01	218.01
15.00	347.8	0.26	1670.58	404.56	202.28	271.28
20.00	399.6	0.35	1919.61	464.46	232.23	301.23
25.00	424.4	0.44	2038.94	492.90	246.45	315.45
30.00	439.6	0.52	2111.57	510.02	255.01	324.01
35.00	447.1	0.61	2147.89	518.34	259.17	328.17
40.00	453.1	0.70	2176.43	524.77	262.38	331.38
45.00	456.3	0.79	2191.99	528.06	264.03	333.03
50.00	457.9	0.88	2199.77	529.47	264.73	333.73
55.00	459.5	0.96	2207.55	530.88	265.44	334.44
60.00	460.6	1.05	2212.74	531.66	265.83	334.83
70.00	461.7	1.23	2217.93	531.97	265.98	334.98
80.00	461.7	1.41	2217.93	531.04	265.52	334.52
90.00	461.2	1.59	2215.34	529.48	264.74	333.74
100.00	459.5	1.77	2207.55	526.69	263.35	332.34
110.00	456.8	1.95	2194.58	522.67	261.34	330.34
120.00	453.6	2.13	2179.02	518.05	259.02	328.02
130.00	449.3	2.31	2158.27	512.20	256.10	325.10
140.00	443.3	2.49	2129.73	504.53	252.27	321.27
150.00	434.2	2.67	2085.63	493.21	246.60	315.60
160.00	420.7	2.86	2020.78	477.02	238.51	307.51
170.00	405.0	3.04	1945.55	458.44	229.22	298.22
180.00	386.6	3.22	1857.36	436.88	218.44	287.44
190.00	368.3	3.41	1769.16	415.39	207.69	276.69
200.00	347.2	3.60	1667.99	390.93	195.46	264.46
210.00	328.3	3.78	1577.19	368.99	184.49	253.49
220.00	315.4	3.97	1514.94	353.78	176.89	245.89
230.00	307.8	4.16	1478.62	344.68	172.34	241.34
240.00	305.6	4.35	1468.24	341.64	170.82	239.82
250.00	304.6	4.54	1463.06	339.82	169.91	238.91
260.00	305.1	4.73	1465.65	339.80	169.90	238.90
270.00	305.1	4.92	1465.65	339.18	169.59	238.59

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE S-219-B ,TESTED ON 09/06/1984 @ 5:00 PM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 2 PARTS PORTLAND CEMENT TYPE(V) + 8 PARTS WATER **
CONFINING PRESSURE = 69 KPA DRY DENSITY = 17.19 KN/M**3
WATER CONTENT AT TESTING = 7.307 % CURE PERIOD = 14 DAYS IN WAX
SAMPLE LENGTH= 14.69 CM SAMPLE AREA= 41.43 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	69.00
5.00	102.8	0.09	493.85	119.11	59.55	128.55
10.00	235.5	0.17	1131.37	272.63	136.32	205.32
15.00	341.1	0.26	1638.69	394.54	197.27	266.27
20.00	406.5	0.35	1952.96	469.80	234.90	303.90
25.00	437.4	0.43	2101.12	505.00	252.50	321.50
30.00	451.4	0.52	2168.46	520.73	260.37	329.37
35.00	457.0	0.61	2195.40	526.75	263.37	332.37
40.00	460.7	0.70	2213.36	530.59	265.30	334.30
45.00	462.1	0.78	2220.09	531.74	265.87	334.87
50.00	463.1	0.87	2224.58	532.35	266.18	335.18
55.00	463.1	0.96	2224.58	531.89	265.95	334.94
60.00	463.1	1.05	2224.58	531.43	265.71	334.71
70.00	462.1	1.23	2220.09	529.43	264.71	333.71
80.00	460.7	1.40	2213.36	526.90	263.45	332.45
90.00	458.9	1.58	2204.38	523.84	261.92	330.92
100.00	456.1	1.76	2190.91	519.72	259.86	328.86
110.00	453.7	1.94	2179.68	516.15	258.08	327.08
120.00	450.5	2.12	2163.97	511.53	255.76	324.76
130.00	447.2	2.30	2148.26	506.92	253.46	322.46
140.00	443.5	2.48	2130.30	501.79	250.90	319.90
150.00	439.7	2.66	2112.34	496.68	248.34	317.34
160.00	435.5	2.85	2092.14	491.06	245.53	314.53
170.00	430.4	3.03	2067.45	484.40	242.20	311.20
180.00	425.2	3.21	2042.75	477.76	238.88	307.88
190.00	419.6	3.40	2015.82	470.62	235.31	304.31
200.00	413.1	3.58	1984.39	462.45	231.23	300.23
210.00	406.5	3.77	1952.96	454.31	227.16	296.16
220.00	396.7	3.95	1905.82	442.55	221.28	290.28
230.00	386.4	4.14	1856.44	430.31	215.15	284.15
240.00	376.2	4.33	1807.05	418.11	209.05	278.05
250.00	366.8	4.52	1762.16	406.98	203.49	272.49
260.00	356.1	4.71	1710.53	394.35	197.17	266.17
270.00	348.6	4.90	1674.61	385.37	192.68	261.68
280.00	340.7	5.09	1636.45	375.90	187.95	256.95
290.00	335.0	5.28	1609.51	369.04	184.52	253.52
300.00	329.0	5.47	1580.33	361.69	180.85	249.85
310.00	325.2	5.66	1562.37	356.93	178.46	247.46
320.00	322.4	5.86	1548.90	353.21	176.60	245.60
340.00	317.8	6.25	1526.45	346.81	173.41	242.41
360.00	316.4	6.64	1519.72	344.01	172.01	241.01
380.00	315.0	7.03	1512.98	341.23	170.61	239.61
400.00	313.1	7.43	1504.00	337.95	168.97	237.97
420.00	312.6	7.83	1501.76	336.19	168.09	237.09
450.00	311.7	8.44	1497.27	333.31	166.65	235.65
470.00	311.7	8.84	1497.27	332.06	166.03	235.03
480.00	311.7	9.05	1497.27	331.43	165.72	234.72
490.00	311.2	9.26	1495.03	330.31	165.16	234.16

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE S-227-A ,TESTED ON 20/06/1984 @ 1:00 PM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 2 PARTS PORTLAND CEMENT TYPE(V) + 8 PARTS WATER **
CONFINING PRESSURE = 69 KPA DRY DENSITY = 17.14 KN/M**3
WATER CONTENT AT TESTING = 7.275 % CURE PERIOD = 14 DAYS IN WAX
SAMPLE LENGTH= 14.71 CM SAMPLE AREA= 41.62 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	69.00
5.00	116.4	0.09	558.99	134.18	67.09	136.09
10.00	245.5	0.17	1179.12	282.79	141.40	210.40
15.00	349.1	0.26	1676.97	401.85	200.92	269.92
20.00	413.6	0.35	1987.04	475.73	237.87	306.87
25.00	445.5	0.43	2139.89	511.88	255.94	324.94
30.00	460.5	0.52	2211.95	528.66	264.33	333.33
35.00	466.8	0.61	2242.52	535.50	267.75	336.75
40.00	469.1	0.70	2253.44	537.64	268.82	337.82
45.00	469.5	0.78	2255.62	537.70	268.85	337.85
50.00	469.5	0.87	2255.62	537.23	268.61	337.61
55.00	468.6	0.96	2251.25	535.72	267.86	336.86
60.00	467.7	1.05	2246.89	534.22	267.11	336.11
70.00	465.5	1.22	2235.97	530.69	265.35	334.35
80.00	463.2	1.40	2225.05	527.18	263.59	332.59
90.00	460.0	1.58	2209.76	522.64	261.32	330.32
100.00	457.3	1.76	2196.66	518.63	259.32	328.32
110.00	454.1	1.94	2181.38	514.12	257.06	326.06
120.00	453.2	2.12	2177.01	512.19	256.09	325.09
130.00	446.4	2.30	2144.26	503.59	251.80	320.79
140.00	442.3	2.48	2124.60	498.09	249.05	318.05
150.00	437.7	2.66	2102.77	492.10	246.05	315.05
160.00	433.2	2.84	2080.93	486.13	243.06	312.06
170.00	427.7	3.02	2054.73	479.16	239.58	308.58
180.00	422.3	3.21	2028.53	472.20	236.10	305.10
190.00	416.8	3.39	2002.33	465.27	232.64	301.64
200.00	410.5	3.58	1971.76	457.35	228.68	297.68
210.00	403.2	3.76	1936.82	448.45	224.22	293.22
220.00	395.0	3.95	1897.51	438.56	219.28	288.28
230.00	386.4	4.13	1856.03	428.20	214.10	283.10
240.00	377.3	4.32	1812.36	417.37	208.69	277.69
250.00	365.0	4.51	1753.40	403.07	201.53	270.53
260.00	353.6	4.70	1698.81	389.81	194.91	263.91
270.00	343.2	4.89	1648.59	377.61	188.80	257.80
280.00	335.5	5.08	1611.47	368.44	184.22	253.22
290.00	329.1	5.27	1580.90	360.79	180.40	249.40
300.00	323.6	5.46	1554.70	354.17	177.08	246.08
310.00	318.6	5.65	1530.68	348.06	174.03	243.03
320.00	315.0	5.85	1513.21	343.46	171.73	240.73
340.00	310.0	6.24	1489.19	336.77	168.39	237.39
360.00	306.8	6.63	1473.90	332.09	166.05	235.05
380.00	304.5	7.02	1462.99	328.42	164.21	233.21
400.00	302.7	7.42	1454.25	325.25	162.63	231.63
420.00	301.4	7.82	1447.70	322.59	161.29	230.29
440.00	300.9	8.22	1445.52	320.90	160.45	229.45
460.00	300.9	8.63	1445.52	319.70	159.85	228.85
470.00	301.4	8.83	1447.70	319.58	159.79	228.79

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE S-201-A ,TESTED ON 23/02/1984 @ 8:00 AM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 2 PARTS PORTLAND CEMENT TYPE(V) + 8 PARTS WATER **
CONFINING PRESSURE = 69 KPA DRY DENSITY = 17.21 KN/M**3
WATER CONTENT AT TESTING = 7.355 % CURE PERIOD = 28 DAYS IN WAX
SAMPLE LENGTH= 14.71 CM SAMPLE AREA= 41.43 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	69.00
5.00	144.7	0.09	695.21	167.67	83.84	152.84
10.00	271.1	0.17	1302.22	313.80	156.90	225.90
15.00	365.0	0.26	1753.59	422.21	211.10	280.10
20.00	428.8	0.35	2059.69	495.48	247.74	316.74
25.00	462.2	0.43	2220.52	533.70	266.85	335.85
30.00	478.4	0.52	2298.35	551.93	275.96	344.96
35.00	486.5	0.61	2337.26	560.79	280.39	349.39
40.00	490.3	0.70	2355.42	564.65	282.33	351.33
45.00	492.5	0.78	2365.79	566.65	283.32	352.32
50.00	493.0	0.87	2368.39	566.77	283.39	352.39
55.00	493.6	0.96	2370.98	566.90	283.45	352.45
60.00	493.0	1.05	2368.39	565.79	282.89	351.89
70.00	491.4	1.22	2360.61	562.94	281.47	350.47
80.00	488.7	1.40	2347.64	558.87	279.44	348.44
90.00	486.0	1.58	2334.66	554.81	277.40	346.40
100.00	482.2	1.76	2316.51	549.53	274.76	343.76
110.00	478.4	1.94	2298.35	544.26	272.13	341.13
120.00	474.1	2.12	2277.60	538.40	269.20	338.20
130.00	468.2	2.30	2249.06	530.72	265.36	334.36
140.00	461.7	2.48	2217.93	522.45	261.22	330.22
150.00	452.5	2.66	2173.83	511.15	255.58	324.58
160.00	439.6	2.84	2111.57	495.63	247.82	316.82
170.00	425.0	3.02	2041.53	478.34	239.17	308.17
180.00	409.3	3.21	1966.31	459.90	229.95	298.95
190.00	392.0	3.39	1883.30	439.69	219.85	288.85
200.00	373.7	3.58	1795.10	418.35	209.18	278.18
210.00	352.1	3.76	1691.33	393.47	196.73	265.73
220.00	336.4	3.95	1616.11	375.29	187.65	256.65
230.00	326.2	4.14	1566.82	363.19	181.60	250.60
240.00	321.3	4.32	1543.47	357.14	178.57	247.57
250.00	318.6	4.51	1530.50	353.50	176.75	245.75
260.00	317.5	4.70	1525.31	351.66	175.83	244.83
270.00	318.6	4.89	1530.50	352.22	176.11	245.11
280.00	319.1	5.08	1533.10	352.18	176.09	245.09

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE S-218-B ,TESTED ON 23/06/1984 @ 9:30 PM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 2 PARTS PORTLAND CEMENT TYPE(V) + 8 PARTS WATER **
CONFINING PRESSURE = 69 KPA DRY DENSITY = 17.22 KN/M**3
WATER CONTENT AT TESTING = 7.367 % CURE PERIOD = 56 DAYS IN WAX
SAMPLE LENGTH= 14.71 CM SAMPLE AREA= 41.27 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	69.00
5.00	129.5	0.09	622.21	150.65	75.32	144.32
10.00	295.2	0.17	1418.28	343.09	171.54	240.54
15.00	414.3	0.26	1990.16	481.02	240.51	309.51
20.00	476.2	0.35	2287.54	552.41	276.21	345.21
25.00	507.6	0.43	2438.52	588.36	294.18	363.18
30.00	519.0	0.52	2493.42	601.09	300.54	369.54
35.00	522.4	0.61	2509.43	604.42	302.21	371.21
40.00	522.9	0.70	2511.72	604.45	302.22	371.22
50.00	519.0	0.87	2493.42	599.00	299.50	368.50
55.00	516.7	0.96	2481.98	595.73	297.87	366.87
60.00	514.3	1.05	2470.54	592.47	296.24	365.24
70.00	509.5	1.22	2447.67	585.96	292.98	361.98
80.00	504.8	1.40	2424.79	579.47	289.74	358.74
90.00	500.0	1.58	2401.92	573.00	286.50	355.50
100.00	495.7	1.76	2381.33	567.09	283.55	352.55
110.00	491.4	1.94	2360.74	561.20	280.60	349.60
120.00	486.7	2.12	2337.87	554.78	277.39	346.39
130.00	482.4	2.30	2317.28	548.93	274.46	343.46
140.00	477.6	2.48	2294.40	542.55	271.28	340.28
150.00	471.9	2.66	2266.95	535.11	267.56	336.55
160.00	466.7	2.84	2241.79	528.23	264.12	333.12
170.00	460.5	3.02	2212.05	520.30	260.15	329.15
180.00	454.3	3.21	2182.31	512.39	256.20	325.20
190.00	447.1	3.39	2148.00	503.44	251.72	320.72
205.00	430.5	3.67	2067.94	483.37	241.69	310.69
210.00	421.9	3.76	2026.76	473.33	236.66	305.66
220.00	402.9	3.95	1935.26	451.15	225.57	294.57
230.00	387.6	4.14	1862.06	433.30	216.65	285.65
240.00	372.4	4.32	1788.86	415.52	207.76	276.76
250.00	359.0	4.51	1724.81	399.92	199.96	268.96
260.00	350.0	4.70	1681.34	389.14	194.57	263.57
270.00	345.7	4.89	1660.75	383.68	191.84	260.84
280.00	344.8	5.08	1656.18	381.93	190.96	259.96
290.00	344.8	5.27	1656.18	381.24	190.62	259.62
300.00	344.8	5.46	1656.18	380.54	190.27	259.27
310.00	345.7	5.66	1660.75	380.90	190.45	259.45
320.00	346.7	5.85	1665.33	381.25	190.63	259.63

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE S-206-A ,TESTED ON 28/02/1984 @ 8:00 AM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 2 PARTS PORTLAND CEMENT TYPE(V) + 8 PARTS WATER **
CONFINING PRESSURE = 69 KPA DRY DENSITY = 17.15 KN/M**3
WATER CONTENT AT TESTING = 6.935 % CURE PERIOD = 1 DAY OUT OF WAX
SAMPLE LENGTH= 14.73 CM SAMPLE AREA= 41.47 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	69.00
5.00	77.0	0.09	369.90	89.13	44.56	113.56
10.00	131.0	0.17	629.30	151.50	75.75	144.75
15.00	171.0	0.26	821.46	197.59	98.79	167.79
20.00	201.0	0.35	965.57	232.05	116.03	185.03
25.00	226.0	0.43	1085.67	260.69	130.34	199.34
30.00	247.0	0.52	1186.55	284.66	142.33	211.33
35.00	262.0	0.61	1258.61	301.69	150.84	219.84
40.00	276.0	0.69	1325.86	317.53	158.77	227.77
45.00	285.0	0.78	1369.09	327.60	163.80	232.80
50.00	292.0	0.87	1402.72	335.36	167.68	236.68
55.00	297.0	0.96	1426.74	340.80	170.40	239.40
60.00	301.0	1.05	1445.96	345.09	172.55	241.55
70.00	305.5	1.22	1467.57	349.64	174.82	243.82
80.00	308.0	1.40	1479.58	351.89	175.94	244.94
90.00	308.5	1.58	1481.98	351.84	175.92	244.92
100.00	308.0	1.75	1479.58	350.66	175.33	244.33
110.00	307.0	1.93	1474.78	348.91	174.45	243.45
120.00	305.0	2.11	1465.17	346.02	173.01	242.01
130.00	303.0	2.29	1455.56	343.15	171.57	240.57
140.00	300.0	2.47	1441.15	339.15	169.58	238.58
150.00	297.5	2.65	1429.14	335.73	167.87	236.87
160.00	294.0	2.84	1412.33	331.20	165.60	234.60
170.00	291.0	3.02	1397.92	327.23	163.62	232.62
180.00	287.5	3.20	1381.10	322.72	161.36	230.36
190.00	284.0	3.39	1364.29	318.23	159.11	228.11
200.00	280.5	3.57	1347.48	313.75	156.87	225.87
210.00	277.0	3.76	1330.66	309.28	154.64	223.64
220.00	273.0	3.94	1311.45	304.27	152.13	221.13
230.00	269.0	4.13	1292.23	299.27	149.64	218.64
240.00	264.0	4.32	1268.21	293.18	146.59	215.59
250.00	260.0	4.50	1249.00	288.22	144.11	213.11
260.00	255.0	4.69	1224.98	282.17	141.08	210.08
270.00	250.0	4.88	1200.96	276.14	138.07	207.07
280.00	245.0	5.07	1176.94	270.12	135.06	204.06
290.00	240.0	5.26	1152.92	264.13	132.07	201.07
300.00	235.0	5.45	1128.90	258.16	129.08	198.08
310.00	230.5	5.65	1107.28	252.76	126.38	195.38
320.00	226.0	5.84	1085.67	247.37	123.68	192.68
340.00	219.0	6.23	1052.04	238.83	119.42	188.42
360.00	212.5	6.62	1020.82	230.90	115.45	184.45
380.00	209.5	7.01	1006.40	226.80	113.40	182.40
400.00	207.0	7.41	994.39	223.27	111.63	180.63
420.00	206.5	7.81	991.99	221.90	110.95	179.95
440.00	206.5	8.21	991.99	221.08	110.54	179.54

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE S-209-A ,TESTED ON 03/03/1984 @ 7:00 PM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 2 PARTS PORTLAND CEMENT TYPE(V) + 8 PARTS WATER **
CONFINING PRESSURE = 69 KPA DRY DENSITY = 17.24 KN/M**3
WATER CONTENT AT TESTING = 2.820 % CURE PERIOD = 3 DAYS OUT OF WAX
SAMPLE LENGTH= 14.73 CM SAMPLE AREA= 40.92 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	69.00
5.00	117.0	0.09	562.05	137.23	68.62	137.62
10.00	195.0	0.17	936.75	228.52	114.26	183.26
15.00	261.0	0.26	1253.80	305.61	152.80	221.80
20.00	301.0	0.35	1445.96	352.14	176.07	245.07
25.00	331.0	0.43	1590.07	386.90	193.45	262.45
30.00	351.0	0.52	1686.15	409.92	204.96	273.96
35.00	364.0	0.61	1748.60	424.74	212.37	281.37
40.00	372.0	0.69	1787.03	433.69	216.85	285.85
45.00	376.0	0.78	1806.24	437.98	218.99	287.99
50.00	379.5	0.87	1823.06	441.67	220.84	289.83
55.00	381.0	0.96	1830.26	443.03	221.52	290.51
60.00	382.0	1.05	1835.07	443.81	221.90	290.90
70.00	382.5	1.22	1837.47	443.61	221.81	290.81
80.00	382.5	1.40	1837.47	442.84	221.42	290.42
90.00	381.5	1.58	1832.66	440.91	220.45	289.45
100.00	380.0	1.75	1825.46	438.41	219.20	288.20
110.00	379.0	1.93	1820.65	436.48	218.24	287.24
120.00	377.0	2.11	1811.05	433.42	216.71	285.71
130.00	375.0	2.29	1801.44	430.36	215.18	284.18
140.00	372.5	2.47	1789.43	426.74	213.37	282.37
150.00	370.0	2.66	1777.42	423.12	211.56	280.56
160.00	367.0	2.84	1763.01	418.95	209.48	278.48
170.00	364.0	3.02	1748.60	414.79	207.39	276.39
180.00	361.0	3.20	1734.19	410.64	205.32	274.32
190.00	357.5	3.39	1717.37	405.93	202.97	271.97
200.00	354.0	3.57	1700.56	401.24	200.62	269.62
210.00	349.5	3.76	1678.94	395.44	197.72	266.72
220.00	345.5	3.94	1659.73	390.21	195.11	264.10
230.00	340.0	4.13	1633.31	383.31	191.66	260.66
240.00	333.5	4.32	1602.08	375.31	187.65	256.65
250.00	325.0	4.51	1561.25	365.08	182.54	251.54
260.00	316.0	4.69	1518.01	354.33	177.17	246.17
270.00	307.0	4.88	1474.78	343.62	171.81	240.81
280.00	299.0	5.07	1436.35	334.06	167.03	236.03
290.00	292.0	5.26	1402.72	325.65	162.82	231.82
300.00	287.5	5.46	1381.10	320.05	160.02	229.02
310.00	284.0	5.65	1364.29	315.58	157.79	226.79
320.00	282.0	5.84	1354.68	312.78	156.39	225.39
340.00	281.0	6.23	1349.88	310.54	155.27	224.27
360.00	280.0	6.62	1345.07	308.30	154.15	223.15
380.00	279.0	7.01	1340.27	306.07	153.03	222.03
400.00	278.0	7.41	1335.47	303.85	151.92	220.92
420.00	278.0	7.81	1335.47	302.72	151.36	220.36

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE S-210-A ,TESTED ON 08/03/1984 @ 9:00 AM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 2 PARTS PORTLAND CEMENT TYPE(V) + 8 PARTS WATER **
CONFINING PRESSURE = 69 KPA DRY DENSITY = 17.15 KN/M**3
WATER CONTENT AT TESTING = 1.986 % CURE PERIOD = 7 DAYS OUT OF WAX
SAMPLE LENGTH= 14.74 CM SAMPLE AREA= 41.31 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	69.00
5.00	144.9	0.09	696.08	168.34	84.17	153.17
10.00	257.3	0.17	1235.79	298.61	149.30	218.30
15.00	333.9	0.26	1604.00	387.25	193.62	262.62
20.00	388.5	0.35	1866.29	450.18	225.09	294.09
25.00	420.0	0.43	2017.61	486.26	243.13	312.13
30.00	437.8	0.52	2103.36	506.49	253.25	322.25
35.00	448.3	0.61	2153.80	518.19	259.09	328.09
40.00	451.5	0.69	2168.93	521.38	260.69	329.69
45.00	453.1	0.78	2176.50	522.74	261.37	330.37
50.00	453.1	0.87	2176.50	522.29	261.14	330.14
55.00	452.6	0.96	2173.98	521.23	260.61	329.61
60.00	451.5	1.04	2168.93	519.57	259.78	328.78
70.00	448.9	1.22	2156.32	515.65	257.82	326.82
80.00	445.7	1.40	2141.19	511.14	255.57	324.57
90.00	442.6	1.57	2126.06	506.64	253.32	322.32
100.00	439.4	1.75	2110.93	502.15	251.08	320.08
110.00	436.3	1.93	2095.79	497.68	248.84	317.84
120.00	432.6	2.11	2078.14	492.62	246.31	315.31
130.00	428.4	2.29	2057.96	486.98	243.49	312.49
140.00	423.7	2.47	2035.27	480.76	240.38	309.38
150.00	418.4	2.65	2010.05	473.96	236.98	305.98
160.00	412.6	2.83	1982.30	466.59	233.30	302.30
170.00	406.3	3.02	1952.04	458.66	229.33	298.33
180.00	395.8	3.20	1901.60	446.01	223.01	292.01
190.00	380.6	3.38	1828.46	428.09	214.05	283.05
200.00	362.3	3.57	1740.19	406.70	203.35	272.35
220.00	326.0	3.94	1566.17	364.73	182.36	251.36
230.00	310.8	4.13	1493.03	347.07	173.54	242.54
240.00	303.4	4.31	1457.72	338.26	169.13	238.13
250.00	298.7	4.50	1435.03	332.39	166.20	235.19
260.00	297.1	4.69	1427.46	330.04	165.02	234.02
270.00	295.1	4.88	1417.37	327.12	163.56	232.56
280.00	293.5	5.07	1409.81	324.78	162.39	231.39
290.00	293.5	5.26	1409.81	324.20	162.10	231.10
300.00	291.9	5.45	1402.24	321.87	160.94	229.94
310.00	291.9	5.64	1402.24	321.29	160.64	229.64
320.00	291.9	5.83	1402.24	320.70	160.35	229.35

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE S-204-A ,TESTED ON 11/03/1984 @ 7:00 PM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 2 PARTS PORTLAND CEMENT TYPE(V) + 8 PARTS WATER **
CONFINING PRESSURE = 69 KPA DRY DENSITY = 17.39 KN/M**3
WATER CONTENT AT TESTING = 1.276 % CURE PERIOD = 14 DAYS OUT OF WAX
SAMPLE LENGTH= 14.72 CM SAMPLE AREA= 41.11 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	69.00
5.00	174.3	0.09	837.31	203.48	101.74	170.74
10.00	333.9	0.17	1604.00	389.46	194.73	263.73
15.00	464.1	0.26	2229.46	540.86	270.43	339.43
20.00	535.5	0.35	2572.46	623.53	311.76	380.76
25.00	569.1	0.43	2733.86	662.08	331.04	400.04
30.00	583.3	0.52	2801.96	677.98	338.99	407.99
35.00	585.9	0.61	2814.57	680.44	340.22	409.22
40.00	582.8	0.70	2799.44	676.19	338.10	407.10
45.00	578.0	0.78	2776.74	670.13	335.06	404.06
50.00	572.3	0.87	2749.00	662.86	331.43	400.43
55.00	567.0	0.96	2723.78	656.20	328.10	397.10
60.00	561.8	1.05	2698.56	649.56	324.78	393.78
70.00	552.3	1.22	2653.16	637.52	318.76	387.76
80.00	543.9	1.40	2612.81	626.73	313.36	382.36
90.00	533.9	1.58	2564.89	614.16	307.08	376.08
100.00	522.9	1.76	2511.93	600.42	300.21	369.21
110.00	508.2	1.93	2441.31	582.52	291.26	360.26
120.00	488.3	2.11	2345.47	558.67	279.33	348.33
130.00	462.0	2.29	2219.37	527.70	263.85	332.85
140.00	437.8	2.48	2103.36	499.23	249.62	318.62
150.00	415.3	2.66	1994.91	472.65	236.33	305.33
160.00	389.6	2.84	1871.34	442.59	221.29	290.29
170.00	372.8	3.02	1790.63	422.75	211.38	280.38
180.00	359.1	3.21	1725.06	406.55	203.27	272.27
190.00	354.4	3.39	1702.36	400.48	200.24	269.24
200.00	353.8	3.57	1699.84	399.17	199.59	268.59
210.00	354.4	3.76	1702.36	399.05	199.53	268.53
220.00	354.9	3.95	1704.88	398.93	199.46	268.46
230.00	357.0	4.13	1714.97	400.57	200.28	269.28
240.00	358.6	4.32	1722.54	401.61	200.81	269.81
250.00	359.1	4.51	1725.06	401.48	200.74	269.74

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE S-202-A ,TESTED ON 22/03/1984 @ 11:00 AM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 2 PARTS PORTLAND CEMENT TYPE(V) + 8 PARTS WATER **
CONFINING PRESSURE = 69 KPA DRY DENSITY = 17.18 KN/M**3
WATER CONTENT AT TESTING = 0.842 % CURE PERIOD = 28 DAYS OUT OF WAX
SAMPLE LENGTH= 14.73 CM SAMPLE AREA= 41.61 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	69.00
5.00	215.0	0.09	1032.83	247.18	123.59	192.59
10.00	384.0	0.17	1844.67	441.09	220.55	289.55
15.00	602.0	0.26	2891.91	690.91	345.45	414.45
20.00	743.0	0.35	3569.25	851.99	426.00	495.00
25.00	806.0	0.43	3871.89	923.43	461.72	530.72
30.00	802.0	0.52	3852.68	918.05	459.03	528.03
35.00	778.0	0.61	3737.39	889.81	444.90	513.90
40.00	749.0	0.70	3598.08	855.90	427.95	496.95
45.00	730.0	0.78	3506.80	833.46	416.73	485.73
50.00	710.0	0.87	3410.73	809.92	404.96	473.96
55.00	695.0	0.96	3338.67	792.12	396.06	465.06
60.00	682.0	1.05	3276.22	776.62	388.31	457.31
70.00	655.0	1.22	3146.51	744.58	372.29	441.29
80.00	620.0	1.40	2978.38	703.56	351.78	420.78
90.00	576.0	1.58	2767.01	652.48	326.24	395.24
100.00	528.0	1.76	2536.43	597.06	298.53	367.53
130.00	260.0	2.30	1249.00	292.46	146.23	215.23
140.00	247.0	2.48	1186.55	277.34	138.67	207.67
150.00	248.0	2.66	1191.35	277.97	138.99	207.99

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE S-217-B ,TESTED ON 02/06/1984 @ 10:30 AM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 2 PARTS PORTLAND CEMENT TYPE(V) + 8 PARTS WATER **
CONFINING PRESSURE = 69 KPA   DRY DENSITY = 17.19 KN/M**3
WATER CONTENT AT TESTING = 0.608 %   CURE PERIOD = 56 DAYS OUT OF WAX
SAMPLE LENGTH= 14.71 CM   SAMPLE AREA= 41.27 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	69.00
5.00	215.3	0.09	1034.03	250.33	125.17	194.17
10.00	430.5	0.17	2068.05	500.24	250.12	319.12
12.00	556.5	0.21	2673.34	646.42	323.21	392.21
14.00	655.2	0.24	3147.47	760.81	380.40	449.40
15.00	696.1	0.26	3344.19	808.22	404.11	473.11
17.00	745.5	0.29	3581.26	865.21	432.61	501.61
20.00	785.4	0.35	3772.93	911.05	455.52	524.52
24.00	804.3	0.42	3863.73	932.32	466.16	535.16
30.00	807.4	0.52	3878.86	935.00	467.50	536.50
35.00	800.1	0.61	3843.55	925.69	462.84	531.84
40.00	790.6	0.70	3798.15	913.96	456.98	525.98
45.00	780.1	0.78	3747.71	901.04	450.52	519.52
50.00	769.6	0.87	3697.27	888.14	444.07	513.07
55.00	761.3	0.96	3656.92	877.68	438.84	507.84
60.00	751.8	1.05	3611.53	866.03	433.01	502.01
70.00	732.9	1.22	3520.73	842.78	421.39	490.39
80.00	712.9	1.40	3424.90	818.41	409.20	478.20
90.00	688.8	1.58	3308.88	789.30	394.65	463.65
100.00	630.0	1.76	3026.42	720.66	360.33	429.33
110.00	577.5	1.94	2774.22	659.44	329.72	398.72
120.00	509.3	2.12	2446.35	580.48	290.24	359.24
130.00	295.1	2.30	1417.37	335.73	167.86	236.86
140.00	295.1	2.48	1417.37	335.14	167.57	236.57

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE S-212-A ,TESTED ON 25/03/1984 @ 9:30 PM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 2 PARTS PORTLAND CEMENT TYPE(V) + 8 PARTS WATER **
CONFINING PRESSURE =138 KPA DRY DENSITY = 17.13 KN/M**3
WATER CONTENT AT TESTING = 7.483 % CURE PERIOD = 14 DAYS IN WAX
SAMPLE LENGTH= 14.71 CM SAMPLE AREA= 41.45 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	138.00
5.00	125.7	0.09	603.65	145.50	72.75	210.75
10.00	271.9	0.17	1306.26	314.58	157.29	295,29
15.00	401.7	0.26	1929.70	464.32	232.16	370.16
20.00	492.3	0.35	2365.12	568.60	284.30	422.30
25.00	559.3	0.43	2686.74	645.36	322.68	460.68
30.00	605.6	0.52	2909.39	698.23	349.12	487.12
35.00	640.7	0.61	3077.63	737.97	368.98	506.98
40.00	664.3	0.70	3191.43	764.59	382.29	520.29
45.00	680.8	0.78	3270.60	782.88	391.44	529.44
50.00	692.2	0.87	3325.02	795.21	397.61	535.61
55.00	699.4	0.96	3359.66	802.79	401.40	539.40
60.00	704.5	1.05	3384.40	808.00	404.00	542.00
70.00	710.2	1.22	3411.61	813.08	406.54	544.54
80.00	712.8	1.40	3423.98	814.60	407.30	545.30
90.00	713.8	1.58	3428.93	814.35	407.17	545.17
100.00	713.8	1.76	3428.93	812.92	406.46	544.46
110.00	712.8	1.94	3423.98	810.32	405.16	543.16
120.00	711.2	2.12	3416.56	807.14	403.57	541.57
130.00	708.6	2.30	3404.19	802.80	401.40	539.40
140.00	705.5	2.48	3389.35	797.89	398.94	536.94
150.00	701.9	2.66	3372.03	792.41	396.20	534.20
160.00	697.3	2.84	3349.76	785.78	392.89	530.89
170.00	693.2	3.02	3329.97	779.75	389.88	527.88
180.00	688.6	3.21	3307.71	773.16	386.58	524.58
190.00	682.9	3.39	3280.49	765.43	382.72	520.72
200.00	677.7	3.58	3255.75	758.30	379.15	517.15
210.00	669.5	3.76	3216.17	747.74	373.87	511.87
220.00	666.4	3.95	3201.32	742.96	371.48	509.48
230.00	660.7	4.14	3174.11	735.32	367.66	505.66
240.00	655.6	4.32	3149.37	728.28	364.14	502.14
250.00	649.4	4.51	3119.68	720.11	360.06	498.06
260.00	643.7	4.70	3092.47	712.54	356.27	494.27
270.00	636.0	4.89	3055.36	702.72	351.36	489.36
285.00	623.1	5.18	2993.51	686.63	343.31	481.31
290.00	618.0	5.27	2968.77	680.33	340.17	478.17
300.00	607.7	5.46	2919.29	667.78	333.89	471.89
310.00	594.3	5.65	2854.97	651.88	325.94	463.94
320.00	578.9	5.85	2780.75	633.77	316.89	454.89
340.00	550.0	6.24	2642.21	599.99	300.00	438.00
360.00	532.0	6.63	2555.62	578.20	289.10	427.10
380.00	521.7	7.02	2506.14	564.92	282.46	420.46
400.00	519.1	7.42	2493.77	560.05	280.03	418.03
420.00	518.1	7.82	2488.82	556.87	278.43	416.43
440.00	517.6	8.22	2486.34	554.25	277.12	415.12
450.00	518.6	8.42	2491.29	554.31	277.16	415.16
460.00	519.1	8.63	2493.77	553.82	276.91	414.91
470.00	519.6	8.83	2496.24	553.33	276.67	414.67

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE S-215-A ,TESTED ON 17/04/1984 @ 8:30 AM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 2 PARTS PORTLAND CEMENT TYPE(V) + 8 PARTS WATER **
CONFINING PRESSURE =207 KPA DRY DENSITY = 17.22 KN/M**3
WATER CONTENT AT TESTING = 7.404 % CURE PERIOD = 14 DAYS IN WAX
SAMPLE LENGTH= 14.72 CM SAMPLE AREA= 41.13 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	207.00
5.00	123.6	0.09	593.75	144.22	72.11	279.11
10.00	267.8	0.17	1286.47	312.21	156.10	363.10
15.00	391.4	0.26	1880.22	455.91	227.96	434.96
20.00	473.8	0.35	2276.06	551.42	275.71	482.71
25.00	545.9	0.43	2622.41	634.78	317.39	524.39
30.00	612.8	0.52	2944.03	712.01	356.01	563.01
35.00	673.6	0.61	3235.96	781.93	390.97	597.97
40.00	738.5	0.70	3547.68	856.51	428.26	635.26
45.00	791.0	0.78	3800.03	916.64	458.32	665.32
50.00	831.2	0.87	3993.00	962.35	481.18	688.18
55.00	858.0	0.96	4121.64	992.49	496.25	703.25
60.00	878.6	1.05	4220.60	1015.44	507.72	714.72
70.00	903.3	1.22	4339.35	1042.19	521.09	728.09
80.00	916.2	1.40	4401.20	1055.19	527.60	734.60
90.00	922.9	1.58	4433.36	1061.05	530.52	737.52
100.00	927.0	1.76	4453.16	1063.91	531.96	738.96
110.00	929.1	1.93	4463.05	1064.41	532.20	739.20
120.00	930.1	2.11	4468.00	1063.71	531.86	738.86
130.00	929.1	2.29	4463.05	1060.66	530.33	737.33
140.00	927.5	2.48	4455.63	1057.03	528.51	735.51
150.00	924.9	2.66	4443.26	1052.23	526.11	733.11
160.00	921.8	2.84	4428.41	1046.86	523.43	730.43
170.00	918.2	3.02	4411.10	1040.91	520.46	727.46
180.00	914.1	3.21	4391.30	1034.40	517.20	724.20
190.00	909.0	3.39	4366.57	1026.74	513.37	720.37
200.00	904.3	3.57	4344.30	1019.68	509.84	716.84
210.00	899.2	3.76	4319.56	1012.07	506.03	713.03
220.00	894.0	3.95	4294.82	1004.47	502.23	709.23
230.00	888.9	4.13	4270.08	996.89	498.44	705.44
240.00	883.7	4.32	4245.34	989.33	494.67	701.67
250.00	878.6	4.51	4220.60	981.80	490.90	697.90
260.00	872.4	4.70	4190.91	973.13	486.57	693.57
270.00	866.2	4.89	4161.23	964.49	482.25	689.25
280.00	860.0	5.08	4131.54	955.88	477.94	684.94
290.00	853.9	5.27	4101.85	947.29	473.65	680.65
300.00	847.7	5.46	4072.16	938.73	469.36	676.36
310.00	841.5	5.65	4042.48	930.19	465.09	672.09
320.00	835.8	5.84	4015.26	922.24	461.12	668.12
340.00	821.9	6.23	3948.47	903.59	451.79	658.79
360.00	810.6	6.62	3894.04	887.86	443.93	650.93
380.00	797.2	7.02	3829.71	869.98	434.99	641.99
400.00	784.9	7.41	3770.34	853.33	426.67	633.67
420.00	775.1	7.81	3723.33	839.57	419.79	626.78
440.00	764.8	8.22	3673.85	825.33	412.67	619.67
480.00	746.2	9.03	3584.79	799.31	399.65	606.65
530.00	734.9	10.07	3530.36	779.77	389.88	596.88
550.00	735.4	10.49	3532.84	777.35	388.67	595.67
560.00	735.9	10.70	3535.31	776.41	388.21	595.21
570.00	737.0	10.91	3540.26	776.01	388.01	595.01
580.00	738.0	11.12	3545.21	775.61	387.80	594.80
590.00	739.5	11.33	3552.63	775.74	387.87	594.87
600.00	741.1	11.55	3560.05	775.87	387.94	594.93

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE S-214-A ,TESTED ON 28/03/1984 @ 2:00 PM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 2 PARTS PORTLAND CEMENT TYPE(V) + 8 PARTS WATER **
CONFINING PRESSURE =276 KPA DRY DENSITY = 17.17 KN/M**3
WATER CONTENT AT TESTING = 7.271 % CURE PERIOD = 14 DAYS IN WAX
SAMPLE LENGTH= 14.71 CM SAMPLE AREA= 41.50 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	276.00
10.00	290.5	0.17	1395.32	335.67	167.84	443.84
15.00	457.3	0.26	2196.89	528.05	264.03	540.03
20.00	597.4	0.35	2869.81	689.20	344.60	620.60
25.00	726.1	0.43	3488.31	837.01	418.50	694.50
30.00	832.2	0.52	3997.95	958.46	479.23	755.23
35.00	916.7	0.61	4403.68	1054.81	527.41	803.41
40.00	981.6	0.70	4715.39	1128.50	564.25	840.25
45.00	1033.1	0.78	4962.79	1186.67	593.34	869.34
50.00	1071.2	0.87	5145.87	1229.38	614.69	890.69
55.00	1099.0	0.96	5279.46	1260.20	630.10	906.10
60.00	1117.5	1.05	5368.53	1280.34	640.17	916.17
70.00	1142.3	1.22	5487.28	1306.38	653.19	929.19
80.00	1155.7	1.40	5551.60	1319.38	659.69	935.69
90.00	1164.9	1.58	5596.13	1327.63	663.82	939.82
100.00	1170.6	1.76	5623.35	1331.75	665.87	941.87
110.00	1173.7	1.94	5638.19	1332.92	666.46	942.46
120.00	1175.2	2.12	5645.61	1332.32	666.16	942.16
130.00	1175.7	2.30	5648.09	1330.56	665.28	941.28
140.00	1175.2	2.48	5645.61	1327.62	663.81	939.81
150.00	1173.2	2.66	5635.71	1322.95	661.48	937.48
160.00	1170.6	2.84	5623.35	1317.71	658.85	934.85
170.00	1164.9	3.02	5596.13	1309.00	654.50	930.50
180.00	1162.9	3.21	5586.24	1304.36	652.18	928.18
190.00	1158.2	3.39	5563.97	1296.85	648.42	924.42
200.00	1153.1	3.58	5539.23	1288.77	644.39	920.39
210.00	1145.4	3.76	5502.12	1277.85	638.93	914.93
220.00	1142.3	3.95	5487.28	1272.12	636.06	912.06
230.00	1136.6	4.14	5460.06	1263.54	631.77	907.77
240.00	1130.4	4.32	5430.38	1254.41	627.20	903.20
250.00	1124.2	4.51	5400.69	1245.30	622.65	898.65
260.00	1117.0	4.70	5366.05	1235.08	617.54	893.54
270.00	1109.3	4.89	5328.94	1224.32	612.16	888.16
280.00	1099.5	5.08	5281.94	1211.33	605.66	881.66
290.00	1087.2	5.27	5222.56	1195.54	597.77	873.77
300.00	1072.2	5.46	5150.82	1176.97	588.48	864.48
310.00	1053.7	5.66	5061.75	1154.51	577.25	853.25
320.00	1034.1	5.85	4967.74	1131.00	565.50	841.50
340.00	999.1	6.24	4799.51	1088.70	544.35	820.35
360.00	971.3	6.63	4665.92	1054.52	527.26	803.26
380.00	954.3	7.02	4584.28	1032.25	516.12	792.12
405.00	944.5	7.52	4537.27	1016.94	508.47	784.47
420.00	947.6	7.82	4552.11	1017.43	508.71	784.71
440.00	952.7	8.22	4576.85	1019.15	509.57	785.57
460.00	959.4	8.63	4609.02	1022.47	511.24	787.24
480.00	962.0	9.04	4621.39	1021.37	510.69	786.69
490.00	964.1	9.24	4631.28	1021.63	510.82	786.82
500.00	964.6	9.45	4633.76	1020.25	510.12	786.12
520.00	965.1	9.87	4636.23	1016.93	508.47	784.47

** DRAINED TRIAXIAL COMPRESION TEST **

** SAMPLE S-213-A ,TESTED ON 27/03/1984 @ 1:00 PM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 2 PARTS PORTLAND CEMENT TYPE(V) + 8 PARTS WATER **
CONFINING PRESSURE = 69 KPA DRY DENSITY = 17.17 KN/M**3
WATER CONTENT AT TESTING = 20.595 % CURE PERIOD = 14 DAYS IN WAX
DGREE OF SATURATION =97.1% SAMPLE LENGTH= 14.71CM SAMPLE AREA= 41.38 CM**2

DDR DIV.	LDR DIV.	BR ML	CS %	VS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	16.40	0.00	0.00	0.00	0.00	0.00	69.00
5.00	103.0	16.00	0.09	-0.07	494.80	120.03	60.02	129.02
10.00	230.7	15.70	0.17	-0.12	1108.34	268.77	134.38	203.38
15.00	331.7	15.60	0.26	-0.13	1593.24	386.08	193.04	262.04
20.00	383.2	15.90	0.35	-0.08	1840.64	445.42	222.71	291.71
25.00	405.8	16.40	0.43	0.00	1949.49	470.97	235.48	304.48
30.00	415.1	17.00	0.52	0.10	1994.02	480.82	240.41	309.41
35.00	417.1	17.70	0.61	0.21	2003.92	482.23	241.11	310.11
40.00	416.6	18.40	0.70	0.33	2001.45	480.65	240.33	309.33
45.00	414.1	19.20	0.78	0.46	1989.08	476.63	238.32	307.32
50.00	409.9	20.00	0.87	0.60	1969.28	470.85	235.43	304.43
55.00	406.3	20.70	0.96	0.71	1951.97	465.76	232.88	301.88
60.00	402.7	21.60	1.05	0.86	1934.65	460.54	230.27	299.27
70.00	395.5	23.20	1.23	1.12	1900.01	450.30	225.15	294.15
80.00	387.8	24.90	1.40	1.40	1862.90	439.49	219.75	288.75
90.00	380.6	26.30	1.58	1.64	1828.27	429.56	214.78	283.78
100.00	372.9	27.80	1.76	1.88	1791.16	419.05	209.53	278.53
110.00	364.6	29.20	1.94	2.12	1751.57	408.12	204.06	273.06
120.00	355.3	30.60	2.12	2.35	1707.04	396.11	198.06	267.06
130.00	343.0	31.90	2.30	2.56	1647.67	380.83	190.41	259.41
140.00	319.3	33.00	2.48	2.74	1533.86	353.24	176.62	245.62
150.00	288.4	33.90	2.66	2.89	1385.43	318.00	159.00	228.00
160.00	259.6	34.40	2.85	2.98	1246.88	285.43	142.72	211.72
170.00	239.0	34.80	3.03	3.04	1147.92	262.12	131.06	200.06
180.00	229.2	35.10	3.21	3.09	1100.92	250.79	125.39	194.39
190.00	225.6	35.30	3.40	3.12	1083.60	246.29	123.15	192.15
200.00	225.1	35.40	3.58	3.14	1081.13	245.22	122.61	191.61
210.00	224.5	35.50	3.77	3.16	1078.65	244.15	122.07	191.07
220.00	224.5	35.60	3.96	3.17	1078.65	243.63	121.82	190.82
230.00	223.5	35.60	4.14	3.17	1073.71	242.04	121.02	190.02

** DRAINED TRIAXIAL COMPRESION TEST **

** SAMPLE S-227-B ,TESTED ON 19/06/1984 @ 10:00 PM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 2 PARTS PORTLAND CEMENT TYPE(V) + 8 PARTS WATER **
CONFINING PRESSURE = 69 KPA DRY DENSITY = 17.26 KN/M**3
WATER CONTENT AT TESTING = 20.797 % CURE PERIOD = 14 DAYS IN WAX
DGREE OF SATURATION =100 % SAMPLE LENGTH= 14.73CM SAMPLE AREA= 40.87 CM**2

DDR DIV.	LDR DIV.	BR ML	CS %	VS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	16.90	0.00	0.00	0.00	0.00	0.00	69.00
5.00	79.8	16.60	0.09	-0.05	383.43	94.07	47.04	116.04
10.00	189.9	16.30	0.17	-0.10	912.29	223.75	111.87	180.87
15.00	286.2	16.10	0.26	-0.13	1375.04	337.06	168.53	237.53
20.00	341.3	16.20	0.35	-0.12	1639.47	401.47	200.73	269.73
25.00	370.6	16.50	0.43	-0.07	1780.50	435.40	217.70	286.70
30.00	384.4	17.00	0.52	0.02	1846.61	450.80	225.40	294.40
35.00	392.2	17.70	0.61	0.13	1884.07	459.00	229.50	298.50
40.00	395.9	18.40	0.70	0.25	1901.70	462.35	231.17	300.17
45.00	396.8	19.10	0.78	0.37	1906.11	462.47	231.24	300.24
50.00	396.3	19.90	0.87	0.50	1903.91	460.92	230.46	299.46
55.00	394.5	20.70	0.96	0.63	1895.09	457.77	228.88	297.88
60.00	392.7	21.50	1.05	0.77	1886.28	454.63	227.31	296.31
70.00	387.2	23.10	1.22	1.03	1859.83	446.27	223.14	292.14
80.00	381.7	24.80	1.40	1.32	1833.39	437.91	218.95	287.95
90.00	376.1	26.40	1.58	1.59	1806.95	429.68	214.84	283.84
100.00	371.1	27.90	1.76	1.84	1782.71	422.11	211.05	280.05
110.00	365.1	29.30	1.94	2.07	1754.06	413.62	206.81	275.81
120.00	358.7	30.70	2.12	2.30	1723.21	404.67	202.34	271.34
130.00	349.1	32.20	2.30	2.55	1676.94	392.12	196.06	265.06
140.00	333.0	33.40	2.48	2.75	1599.81	372.66	186.33	255.33
150.00	309.2	34.40	2.66	2.92	1485.22	344.77	172.38	241.38
160.00	288.1	35.20	2.84	3.05	1383.86	320.22	160.11	229.11
170.00	268.8	35.90	3.03	3.17	1291.31	297.90	148.95	217.95
180.00	247.7	36.30	3.21	3.24	1189.94	273.82	136.91	205.91
190.00	232.6	36.50	3.39	3.27	1117.22	256.52	128.26	197.26
200.00	224.8	36.70	3.58	3.30	1079.76	247.36	123.68	192.68
210.00	221.1	36.80	3.76	3.32	1062.13	242.81	121.41	190.41
220.00	220.2	36.80	3.95	3.32	1057.73	241.34	120.67	189.67
230.00	221.1	36.90	4.14	3.34	1062.13	241.83	120.92	189.92

** DRAINED TRIAXIAL COMPRESION TEST **

** SAMPLE S-216-B ,TESTED ON 18/04/1984 @ 7:00 PM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 2 PARTS PORTLAND CEMENT TYPE(V) + 8 PARTS WATER **
CONFINING PRESSURE =138 KPA   DRY DENSITY = 17.11 KN/M**3
WATER CONTENT AT TESTING = 20.714 %   CURE PERIOD = 14 DAYS IN WAX
DGREE OF SATURATION =99.5%   SAMPLE LENGTH= 14.70CM   SAMPLE AREA= 41.69 CM**2

DDR DIV.	LDR DIV.	BR ML	CS %	VS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	17.50	0.00	0.00	0.00	0.00	0.00	138.00
5.00	175.1	17.00	0.09	-0.08	841.15	203.41	101.71	239.71
10.00	326.5	16.80	0.17	-0.12	1568.50	379.10	189.55	327.55
15.00	440.8	16.60	0.26	-0.15	2117.72	511.57	255.79	393.78
20.00	521.2	16.70	0.35	-0.13	2503.66	604.17	302.09	440.09
25.00	573.7	16.90	0.43	-0.10	2756.01	664.27	332.13	470.13
30.00	606.7	17.10	0.52	-0.07	2914.34	701.58	350.79	488.79
35.00	627.3	17.50	0.61	0.00	3013.30	724.29	362.14	500.14
40.00	639.1	18.00	0.70	0.08	3070.20	736.71	368.35	506.35
45.00	644.8	18.50	0.78	0.16	3097.42	741.97	370.99	508.99
50.00	647.9	19.00	0.87	0.25	3112.26	744.25	372.13	510.13
55.00	649.4	19.60	0.96	0.35	3119.68	744.63	372.32	510.32
60.00	649.9	20.10	1.05	0.43	3122.16	743.95	371.97	509.97
70.00	649.4	21.10	1.23	0.59	3119.68	740.81	370.41	508.41
80.00	646.8	22.20	1.40	0.77	3107.31	735.23	367.61	505.61
90.00	643.2	23.40	1.58	0.97	3089.99	728.38	364.19	502.19
100.00	638.6	24.50	1.76	1.15	3067.73	720.52	360.26	498.26
110.00	634.0	25.50	1.94	1.32	3045.46	712.82	356.41	494.41
120.00	627.8	26.50	2.12	1.48	3015.78	703.44	351.72	489.72
130.00	622.1	27.50	2.30	1.65	2988.56	694.67	347.34	485.34
140.00	615.4	28.50	2.48	1.81	2956.40	684.81	342.41	480.41
150.00	608.2	29.50	2.66	1.98	2921.76	674.44	337.22	475.22
160.00	601.0	30.20	2.85	2.09	2887.13	664.44	332.22	470.22
170.00	592.8	31.00	3.03	2.22	2847.55	653.25	326.62	464.62
180.00	583.5	31.90	3.21	2.37	2803.01	640.88	320.44	458.44
190.00	574.7	32.60	3.40	2.49	2760.96	629.35	314.68	452.68
200.00	561.9	33.20	3.58	2.59	2699.11	613.49	306.74	444.74
210.00	544.9	33.90	3.77	2.70	2617.47	593.11	296.56	434.56
220.00	517.1	34.50	3.96	2.80	2483.87	561.21	280.61	418.60
230.00	487.2	35.00	4.14	2.88	2340.38	527.34	263.67	401.67
240.00	468.6	35.40	4.33	2.95	2251.32	505.95	252.97	390.97
270.00	449.1	35.80	4.90	3.01	2157.31	481.64	240.82	378.82
280.00	451.1	36.00	5.09	3.05	2167.20	482.72	241.36	379.36
290.00	451.7	36.00	5.28	3.05	2169.68	482.30	241.15	379.15
300.00	452.7	36.10	5.47	3.06	2174.62	482.34	241.17	379.17
310.00	453.2	36.10	5.67	3.06	2177.10	481.90	240.95	378.95
320.00	454.2	36.10	5.86	3.06	2182.05	482.01	241.00	379.00

** DRAINED TRIAXIAL COMPRESION TEST **

** SAMPLE S-219-A ,TESTED ON 09/06/1984 @ 2:30 PM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 2 PARTS PORTLAND CEMENT TYPE(V) + 8 PARTS WATER **
CONFINING PRESSURE =207 KPA DRY DENSITY = 17.22 KN/M**3
WATER CONTENT AT TESTING = 20.508 % CURE PERIOD = 14 DAYS IN WAX
DGREE OF SATURATION =100 % SAMPLE LENGTH= 14.75CM SAMPLE AREA= 41.43 CM**2

DDR DIV.	LDR DIV.	BR ML	CS %	VS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	14.30	0.00	0.00	0.00	0.00	0.00	207.00
5.00	97.2	14.10	0.09	-0.03	467.04	113.24	56.62	263.62
10.00	268.5	13.70	0.17	-0.10	1289.92	312.69	156.35	363.35
15.00	432.4	13.40	0.26	-0.15	2077.21	503.35	251.68	458.68
20.00	570.4	13.20	0.35	-0.18	2739.97	663.59	331.80	538.80
25.00	674.1	13.10	0.43	-0.20	3238.14	783.69	391.84	598.84
30.00	758.3	13.20	0.52	-0.18	3642.91	880.73	440.37	647.37
35.00	813.9	13.40	0.61	-0.15	3909.79	944.11	472.06	679.06
40.00	850.0	13.70	0.70	-0.10	4083.26	984.65	492.32	699.32
45.00	875.0	14.10	0.78	-0.03	4203.36	1012.04	506.02	713.02
50.00	888.9	14.50	0.87	0.03	4270.08	1026.52	513.26	720.26
55.00	896.3	15.00	0.96	0.12	4305.66	1033.31	516.65	723.65
60.00	900.5	15.50	1.05	0.20	4325.68	1036.33	518.17	725.17
70.00	902.8	16.40	1.22	0.35	4336.80	1035.61	517.80	724.80
80.00	901.9	17.40	1.40	0.51	4332.35	1031.00	515.50	722.50
90.00	898.6	18.40	1.58	0.68	4316.78	1023.76	511.88	718.88
100.00	894.4	19.50	1.76	0.86	4296.77	1015.34	507.67	714.67
110.00	889.4	20.50	1.94	1.02	4272.30	1006.07	503.04	710.04
120.00	883.8	21.50	2.12	1.19	4245.61	996.33	498.16	705.16
130.00	877.8	22.50	2.30	1.35	4216.70	986.11	493.06	700.05
140.00	870.4	23.40	2.48	1.50	4181.12	974.55	487.28	694.28
150.00	863.0	24.30	2.66	1.65	4145.53	963.05	481.52	688.52
160.00	854.6	25.20	2.84	1.80	4105.50	950.57	475.29	682.29
170.00	847.2	26.10	3.02	1.95	4069.92	939.19	469.60	676.60
180.00	837.5	26.90	3.21	2.08	4023.21	925.46	462.73	669.73
190.00	828.7	27.70	3.39	2.21	3980.96	912.82	456.41	663.41
200.00	819.4	28.50	3.58	2.34	3936.48	899.73	449.86	656.86
210.00	809.3	29.20	3.76	2.46	3887.55	885.84	442.92	649.92
220.00	800.0	29.80	3.95	2.56	3843.07	873.16	436.58	643.58
230.00	788.4	30.30	4.14	2.64	3787.47	858.17	429.08	636.08
240.00	774.5	30.80	4.32	2.72	3720.75	840.72	420.36	627.36
250.00	757.4	31.20	4.51	2.79	3638.46	819.99	409.99	616.99
260.00	737.0	31.60	4.70	2.85	3540.61	795.84	397.92	604.92
270.00	713.9	32.00	4.89	2.92	3429.41	768.82	384.41	591.41
280.00	688.9	32.10	5.08	2.94	3309.31	740.29	370.15	577.15
290.00	668.5	32.20	5.27	2.95	3211.45	716.84	358.42	565.42
300.00	649.5	32.30	5.46	2.97	3120.27	694.97	347.48	554.48
310.00	638.9	32.30	5.66	2.97	3069.12	682.19	341.09	548.09
320.00	633.8	32.30	5.85	2.97	3044.65	675.36	337.68	544.68
330.00	634.3	32.30	6.04	2.97	3046.88	674.46	337.23	544.23
340.00	637.0	32.30	6.24	2.97	3060.22	676.02	338.01	545.01
350.00	638.9	32.30	6.43	2.97	3069.12	676.57	338.28	545.28
370.00	640.3	32.30	6.82	2.97	3075.79	675.20	337.60	544.60
380.00	641.7	32.30	7.02	2.97	3082.46	675.23	337.61	544.61

** DRAINED TRIAXIAL COMPRESION TEST **

** SAMPLE S-214-B ,TESTED ON 28/03/1984 @ 2:30 PM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 2 PARTS PORTLAND CEMENT TYPE(V) + 8 PARTS WATER **
CONFINING PRESSURE =276 KPA DRY DENSITY = 17.13 KN/M**3
WATER CONTENT AT TESTING = 20.911 % CURE PERIOD = 14 DAYS IN WAX
DGREE OF SATURATION =99.7% SAMPLE LENGTH= 14.73CM SAMPLE AREA= 41.45 CM**2

DDR DIV.	LDR DIV.	BR ML	CS %	VS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	25.20	0.00	0.00	0.00	0.00	0.00	276.00
5.00	108.1	25.10	0.09	-0.02	519.53	125.78	62.89	338.89
10.00	303.8	24.80	0.17	-0.07	1459.65	353.24	176.62	452.62
15.00	478.9	24.50	0.26	-0.12	2300.80	556.60	278.30	554.30
20.00	648.9	24.30	0.35	-0.15	3117.21	753.69	376.84	652.84
25.00	793.1	24.10	0.43	-0.18	3809.92	920.68	460.34	736.34
30.00	901.2	24.10	0.52	-0.18	4329.46	1045.30	522.65	798.65
35.00	981.6	24.20	0.61	-0.16	4715.39	1137.30	568.65	844.65
40.00	1043.4	24.30	0.70	-0.15	5012.27	1207.64	603.82	879.82
50.00	1113.4	24.90	0.87	-0.05	5348.73	1285.15	642.58	918.58
55.00	1130.9	25.30	0.96	0.02	5432.85	1303.35	651.67	927.67
60.00	1141.2	25.60	1.05	0.07	5482.33	1313.39	656.70	932.70
70.00	1155.7	26.40	1.22	0.20	5551.60	1325.87	662.93	938.93
80.00	1161.3	27.10	1.40	0.31	5578.81	1328.44	664.22	940.22
90.00	1163.4	27.90	1.58	0.45	5588.71	1326.65	663.33	939.33
100.00	1164.4	28.80	1.76	0.59	5593.66	1323.46	661.73	937.73
110.00	1162.4	29.60	1.94	0.73	5583.76	1316.99	658.49	934.49
120.00	1159.3	30.30	2.12	0.84	5568.92	1309.57	654.79	930.79
130.00	1154.6	31.10	2.30	0.97	5546.65	1300.23	650.12	926.12
140.00	1149.0	31.80	2.48	1.09	5519.44	1289.98	644.99	920.99
150.00	1142.8	32.60	2.66	1.22	5489.75	1278.98	639.49	915.49
160.00	1136.1	33.30	2.84	1.34	5457.59	1267.66	633.83	909.83
170.00	1128.9	34.00	3.03	1.45	5422.95	1255.81	627.91	903.91
180.00	1121.2	34.70	3.21	1.57	5385.84	1243.44	621.72	897.72
190.00	1112.4	35.30	3.39	1.66	5343.79	1230.18	615.09	891.09
200.00	1102.6	36.00	3.58	1.78	5296.78	1215.64	607.82	883.82
210.00	1093.9	36.60	3.77	1.88	5254.72	1202.50	601.25	877.25
220.00	1083.6	37.10	3.95	1.96	5205.24	1187.91	593.95	869.95
230.00	1072.7	37.70	4.14	2.06	5153.29	1172.62	586.31	862.31
240.00	1060.4	38.20	4.33	2.14	5093.91	1155.91	577.95	853.95
250.00	1047.5	38.70	4.52	2.23	5032.07	1138.71	569.35	845.35
260.00	1033.1	39.10	4.70	2.29	4962.79	1120.08	560.04	836.04
270.00	1019.7	39.50	4.89	2.36	4898.47	1102.66	551.33	827.33
280.00	1004.2	39.90	5.08	2.42	4824.25	1083.07	541.54	817.54
290.00	988.8	40.20	5.28	2.47	4750.03	1063.75	531.88	807.88
300.00	972.3	40.50	5.47	2.52	4670.86	1043.40	521.70	797.70
310.00	956.4	40.70	5.66	2.55	4594.17	1023.85	511.92	787.92
320.00	945.5	40.80	5.85	2.57	4542.22	1010.03	505.02	781.02
340.00	934.2	41.10	6.24	2.62	4487.79	993.33	496.67	772.66
360.00	921.8	41.30	6.63	2.65	4428.41	975.78	487.89	763.89
380.00	906.4	41.50	7.03	2.69	4354.20	955.07	477.53	753.53
400.00	890.9	41.70	7.43	2.72	4279.98	934.47	467.24	743.24
420.00	871.4	41.90	7.83	2.75	4185.96	909.70	454.85	730.85
440.00	864.2	42.00	8.23	2.77	4151.33	898.08	449.04	725.04
460.00	839.4	42.20	8.64	2.80	4032.58	868.25	434.13	710.13
480.00	836.4	42.20	9.05	2.80	4017.74	861.18	430.59	706.59
500.00	838.9	42.20	9.46	2.80	4030.11	859.91	429.96	705.96
520.00	846.7	42.30	9.87	2.82	4067.22	863.71	431.85	707.85
580.00	871.9	42.30	11.14	2.82	4188.44	876.96	438.48	714.48

** DRAINED TRIAXIAL COMPRESION TEST **

** SAMPLE S-220-A ,TESTED ON 03/05/1984 @ 4:00 PM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 2 PARTS PORTLAND CEMENT TYPE(V) + 8 PARTS WATER **
CONFINING PRESSURE = 69 KPA DRY DENSITY = 17.33 KN/M**3
WATER CONTENT AT TESTING = 20.796 % CURE PERIOD = 7 DAYS OUT OF WAX
DGREE OF SATURATION =100 % SAMPLE LENGTH= 14.70CM SAMPLE AREA= 41.18 CM**2

DDR DIV.	LDR DIV.	BR ML	CS %	VS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	16.70	0.00	0.00	0.00	0.00	0.00	69.00
5.00	160.7	16.30	0.09	-0.07	771.74	188.07	94.03	163.03
10.00	349.6	16.10	0.17	-0.10	1679.66	409.10	204.55	273.55
15.00	456.8	16.10	0.26	-0.10	2194.15	533.94	266.97	335.97
20.00	483.0	16.60	0.35	-0.02	2320.25	563.67	281.83	350.83
25.00	485.6	17.10	0.43	0.07	2332.86	565.77	282.88	351.88
30.00	485.6	17.80	0.52	0.18	2332.86	564.61	282.31	351.31
35.00	484.1	18.50	0.61	0.30	2325.30	561.63	280.82	349.82
40.00	481.9	19.40	0.70	0.45	2315.21	557.87	278.94	347.94
45.00	478.8	20.20	0.79	0.58	2300.08	553.01	276.50	345.50
50.00	475.6	21.00	0.87	0.71	2284.94	548.16	274.08	343.08
55.00	472.0	21.90	0.96	0.86	2267.29	542.63	271.32	340.32
60.00	468.3	22.80	1.05	1.01	2249.64	537.13	268.56	337.56
70.00	462.5	24.40	1.23	1.28	2221.90	528.17	264.08	333.08
80.00	455.7	26.10	1.40	1.56	2189.11	517.99	259.00	328.00
90.00	449.9	27.80	1.58	1.84	2161.37	509.09	254.54	323.54
100.00	441.5	29.50	1.76	2.13	2121.01	497.30	248.65	317.65
110.00	433.6	31.00	1.94	2.38	2083.18	486.35	243.17	312.17
120.00	423.7	32.80	2.12	2.67	2035.27	472.91	236.45	305.45
130.00	411.6	34.20	2.30	2.91	1977.26	457.54	228.77	297.77
140.00	396.9	35.50	2.48	3.12	1906.64	439.46	219.73	288.73
150.00	380.1	36.70	2.67	3.32	1825.94	419.26	209.63	278.63
160.00	359.1	38.00	2.85	3.54	1725.06	394.53	197.26	266.26
170.00	343.3	38.60	3.03	3.64	1649.40	376.15	188.08	257.08
180.00	327.6	39.20	3.22	3.74	1573.74	357.87	178.94	247.94
190.00	314.5	39.70	3.40	3.82	1510.69	342.60	171.30	240.30
200.00	307.6	40.10	3.59	3.89	1477.90	334.31	167.16	236.16
210.00	301.9	40.50	3.77	3.95	1450.16	327.19	163.60	232.60
220.00	299.3	40.80	3.96	4.00	1437.55	323.56	161.78	230.78
230.00	299.8	41.10	4.15	4.05	1440.07	323.34	161.67	230.67
240.00	300.3	41.40	4.33	4.10	1442.59	323.12	161.56	230.56
250.00	299.3	41.70	4.52	4.15	1437.55	321.20	160.60	229.60
260.00	299.8	41.90	4.71	4.19	1440.07	321.02	160.51	229.51

** DRAINED TRIAXIAL COMPRESION TEST **

** SAMPLE S-217-A ,TESTED ON 21/04/1984 @ 10:00 AM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 2 PARTS PORTLAND CEMENT TYPE(V) + 8 PARTS WATER **
CONFINING PRESSURE = 69 KPA DRY DENSITY = 17.19 KN/M**3
WATER CONTENT AT TESTING = 20.389 % CURE PERIOD = 14 DAYS OUT OF WAX
DGREE OF SATURATION =97.9% SAMPLE LENGTH= 14.72CM SAMPLE AREA= 41.45 CM**2

DDR DIV.	LDR DIV.	BR ML	CS %	VS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	17.40	0.00	0.00	0.00	0.00	0.00	69.00
5.00	178.4	17.00	0.09	-0.07	857.16	207.36	103.68	172.68
10.00	392.2	16.60	0.17	-0.13	1883.86	455.64	227.82	296.82
15.00	496.1	16.80	0.26	-0.10	2383.08	575.69	287.85	356.85
20.00	505.9	17.70	0.35	0.05	2430.18	585.69	292.84	361.84
30.00	482.4	18.80	0.52	0.23	2317.14	556.46	278.23	347.23
40.00	465.7	20.50	0.70	0.51	2237.08	534.80	267.40	336.40
50.00	451.0	22.20	0.87	0.79	2166.43	515.56	257.78	326.78
55.00	441.2	24.00	0.96	1.09	2119.34	502.43	251.21	320.21
60.00	431.4	25.50	1.05	1.33	2072.24	489.63	244.81	313.81
70.00	422.5	27.10	1.22	1.60	2029.86	477.51	238.76	307.76
80.00	414.7	28.50	1.40	1.83	1992.18	466.75	233.38	302.38
90.00	406.9	30.00	1.58	2.07	1954.50	455.99	228.00	297.00
100.00	398.0	31.50	1.76	2.32	1912.11	444.22	222.11	291.11
110.00	389.2	33.00	1.94	2.57	1869.73	432.53	216.27	285.27
120.00	377.9	34.40	2.12	2.80	1815.57	418.30	209.15	278.15
130.00	365.2	35.70	2.30	3.01	1754.34	402.61	201.30	270.30
140.00	351.0	36.90	2.48	3.21	1686.05	385.48	192.74	261.74
160.00	333.8	38.00	2.84	3.39	1603.63	364.63	182.31	251.31
170.00	313.7	38.80	3.03	3.52	1507.09	341.59	170.80	239.80
180.00	291.2	39.60	3.21	3.65	1398.76	316.04	158.02	227.02
190.00	266.7	40.10	3.39	3.74	1281.02	288.65	144.33	213.33
200.00	266.7	40.10	3.58	3.74	1281.02	288.10	144.05	213.05

** DRAINED TRIAXIAL COMPRESION TEST **

** SAMPLE S-220-B ,TESTED ON 20/06/1984 @ 11:00 AM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 2 PARTS PORTLAND CEMENT TYPE(V) + 8 PARTS WATER **
CONFINING PRESSURE = 69 KPA DRY DENSITY = 17.11 KN/M**3
WATER CONTENT AT TESTING = 20.704 % CURE PERIOD = 28 DAYS OUT OF WAX
DGREE OF SATURATION =100 % SAMPLE LENGTH= 14.70CM SAMPLE AREA= 41.69 CM**2

DDR DIV.	LDR DIV.	BR ML	CS %	VS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	11.30	0.00	0.00	0.00	0.00	0.00	69.00
5.00	157.5	11.00	0.09	-0.05	756.60	182.14	91.07	160.07
10.00	336.0	10.50	0.17	-0.13	1614.09	388.55	194.27	263.27
15.00	441.0	10.30	0.26	-0.16	2118.49	509.69	254.85	323.85
20.00	479.8	10.40	0.35	-0.15	2305.12	554.02	277.01	346.01
25.00	486.7	10.90	0.43	-0.07	2337.91	560.95	280.47	349.47
30.00	483.0	11.40	0.52	0.02	2320.25	555.77	277.88	346.88
35.00	479.3	12.00	0.61	0.11	2302.60	550.51	275.26	344.26
40.00	477.2	12.80	0.70	0.25	2292.51	546.90	273.45	342.45
45.00	474.6	13.60	0.79	0.38	2279.90	542.70	271.35	340.35
50.00	471.4	14.40	0.87	0.51	2264.77	537.91	268.96	337.96
55.00	468.8	15.20	0.96	0.64	2252.16	533.75	266.87	335.87
60.00	465.7	16.10	1.05	0.79	2237.03	528.91	264.46	333.46
70.00	460.4	17.60	1.23	1.03	2211.81	520.74	260.37	329.37
80.00	455.2	19.20	1.40	1.30	2186.59	512.54	256.27	325.27
90.00	449.9	20.80	1.58	1.56	2161.37	504.41	252.20	321.20
100.00	444.7	22.40	1.76	1.82	2136.15	496.33	248.17	317.17
110.00	438.9	23.80	1.94	2.05	2108.40	487.89	243.95	312.95
120.00	433.1	25.30	2.12	2.30	2080.66	479.43	239.71	308.71
130.00	425.8	26.70	2.30	2.53	2045.35	469.37	234.68	303.68
140.00	415.8	28.10	2.48	2.76	1997.44	456.50	228.25	297.25
150.00	401.1	29.40	2.67	2.97	1926.82	438.63	219.31	288.31
160.00	378.5	30.50	2.85	3.15	1818.37	412.44	206.22	275.22
170.00	354.9	31.40	3.03	3.30	1704.88	385.42	192.71	261.71
180.00	329.7	32.10	3.22	3.41	1583.82	356.97	178.49	247.49
190.00	308.3	32.60	3.40	3.50	1480.93	332.88	166.44	235.44
200.00	279.3	32.80	3.59	3.53	1341.71	300.91	150.46	219.46
210.00	257.8	32.90	3.77	3.55	1238.31	277.14	138.57	207.57
220.00	252.0	32.90	3.96	3.55	1210.57	270.41	135.20	204.20
230.00	253.1	32.80	4.15	3.53	1215.61	271.05	135.52	204.52
240.00	255.2	32.80	4.33	3.53	1225.70	272.76	136.38	205.38
250.00	256.7	32.80	4.52	3.53	1233.26	273.90	136.95	205.95
260.00	258.8	32.80	4.71	3.53	1243.35	275.59	137.80	206.80
270.00	259.3	32.80	4.90	3.53	1245.87	275.60	137.80	206.80
280.00	259.9	32.80	5.09	3.53	1248.40	275.61	137.80	206.80

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE S-101-A ,TESTED ON 12/03/1984 @ 1:00 PM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 1 PART PORTLAND CEMENT TYPE(V) + 8 PARTS WATER **
CONFINING PRESSURE = 69 KPA DRY DENSITY = 16.96 KN/M**3
WATER CONTENT AT TESTING = N.A. CURE PERIOD = 7 DAYS IN WAX
SAMPLE LENGTH= 14.73 CM SAMPLE AREA= 41.61 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	69.00
5.00	86.1	0.09	413.61	99.31	49.66	118.66
10.00	141.8	0.17	680.94	163.36	81.68	150.68
15.00	178.5	0.26	857.49	205.53	102.77	171.77
20.00	210.0	0.35	1008.81	241.59	120.80	189.80
30.00	253.1	0.52	1215.61	290.62	145.31	214.31
35.00	267.8	0.61	1286.23	307.23	153.62	222.62
40.00	279.3	0.69	1341.71	320.21	160.10	229.10
45.00	287.2	0.78	1379.54	328.95	164.48	233.48
50.00	292.9	0.87	1407.28	335.27	167.64	236.64
55.00	297.7	0.96	1429.98	340.39	170.19	239.19
60.00	301.3	1.05	1447.64	344.29	172.14	241.14
70.00	306.6	1.22	1472.86	349.68	174.84	243.84
80.00	310.3	1.40	1490.51	353.25	176.63	245.62
90.00	312.4	1.58	1500.60	355.02	177.51	246.51
100.00	313.9	1.75	1508.17	356.18	178.09	247.09
110.00	315.0	1.93	1513.21	356.75	178.37	247.37
120.00	315.5	2.11	1515.73	356.71	178.36	247.36
130.00	315.5	2.29	1515.73	356.09	178.04	247.04
140.00	315.5	2.47	1515.73	355.46	177.73	246.73
150.00	315.0	2.66	1513.21	354.24	177.12	246.12
160.00	313.9	2.84	1508.17	352.43	176.22	245.22
170.00	312.9	3.02	1503.12	350.63	175.32	244.32
180.00	311.8	3.20	1498.08	348.83	174.42	243.42
190.00	310.3	3.39	1490.51	346.46	173.23	242.23
200.00	308.7	3.57	1482.94	344.08	172.04	241.04
210.00	307.1	3.76	1475.38	341.72	170.86	239.86
220.00	305.0	3.94	1465.29	338.77	169.39	238.39
230.00	302.4	4.13	1452.68	335.25	167.63	236.63
240.00	299.8	4.32	1440.07	331.75	165.87	234.87
250.00	296.1	4.51	1422.42	327.09	163.55	232.55
260.00	291.9	4.69	1402.24	321.87	160.94	229.94
270.00	288.2	4.88	1384.59	317.24	158.62	227.62
280.00	284.0	5.07	1364.41	312.06	156.03	225.03
290.00	279.8	5.26	1344.23	306.88	153.44	222.44
300.00	276.1	5.46	1326.58	302.30	151.15	220.15
310.00	272.5	5.65	1308.92	297.74	148.87	217.87
320.00	268.3	5.84	1288.75	292.62	146.31	215.31
340.00	263.0	6.23	1263.53	285.84	142.92	211.92
360.00	259.9	6.62	1248.40	281.38	140.69	209.69
380.00	258.8	7.01	1243.35	279.22	139.61	208.61
400.00	258.8	7.41	1243.35	278.19	139.09	208.09
420.00	258.8	7.81	1243.35	277.16	138.58	207.58

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE S-101-B ,TESTED ON 12/03/1984 @ 2:30 PM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 1 PART PORTLAND CEMENT TYPE(V) + 8 PARTS WATER **
CONFINING PRESSURE = 69 KPA DRY DENSITY = 17.15 KN/M**3
WATER CONTENT AT TESTING = N.A. CURE PERIOD = 7 DAYS IN WAX
SAMPLE LENGTH= 14.73 CM SAMPLE AREA= 40.91 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	69.00
5.00	84.0	0.09	403.52	98.56	49.28	118.28
10.00	138.6	0.17	665.81	162.48	81.24	150.24
15.00	178.5	0.26	857.49	209.08	104.54	173.54
20.00	210.0	0.35	1008.81	245.76	122.88	191.88
25.00	233.1	0.43	1119.78	272.56	136.28	205.28
30.00	253.6	0.52	1218.13	296.24	148.12	217.12
35.00	265.6	0.61	1276.14	310.08	155.04	224.04
40.00	276.1	0.69	1326.58	322.06	161.03	230.03
45.00	283.5	0.78	1361.89	330.34	165.17	234.17
50.00	289.3	0.87	1389.63	336.78	168.39	237.39
55.00	293.5	0.96	1409.81	341.37	170.69	239.69
60.00	296.1	1.05	1422.42	344.13	172.06	241.06
70.00	300.8	1.22	1445.11	349.01	174.50	243.50
80.00	303.4	1.40	1457.72	351.44	175.72	244.72
90.00	305.6	1.58	1467.81	353.25	176.63	245.63
100.00	306.6	1.76	1472.86	353.84	176.92	245.92
110.00	307.1	1.93	1475.38	353.83	176.91	245.91
120.00	307.1	2.11	1475.38	353.21	176.60	245.60
130.00	307.1	2.29	1475.38	352.58	176.29	245.29
140.00	306.6	2.47	1472.86	351.36	175.68	244.68
150.00	306.1	2.66	1470.33	350.14	175.07	244.07
160.00	305.0	2.84	1465.29	348.32	174.16	243.16
170.00	304.0	3.02	1460.25	346.51	173.25	242.25
180.00	302.9	3.20	1455.20	344.70	172.35	241.35
190.00	301.3	3.39	1447.64	342.29	171.15	240.15
200.00	299.8	3.57	1440.07	339.90	169.95	238.95
210.00	298.2	3.76	1432.50	337.51	168.75	237.75
220.00	296.6	3.94	1424.94	335.12	167.56	236.56
230.00	295.1	4.13	1417.37	332.75	166.37	235.37
240.00	293.5	4.32	1409.81	330.38	165.19	234.19
250.00	291.4	4.51	1399.72	327.42	163.71	232.71
260.00	289.3	4.70	1389.63	324.48	162.24	231.24
270.00	287.2	4.88	1379.54	321.54	160.77	229.77
280.00	284.0	5.07	1364.41	317.44	158.72	227.72
290.00	280.9	5.27	1349.28	313.35	156.67	225.67
300.00	276.7	5.46	1329.10	308.10	154.05	223.05
310.00	273.0	5.65	1311.45	303.46	151.73	220.73
320.00	267.8	5.84	1286.23	297.08	148.54	217.54
340.00	261.4	6.23	1255.96	289.03	144.51	213.51
360.00	257.3	6.62	1235.79	283.34	141.67	210.67
380.00	254.6	7.01	1223.18	279.42	139.71	208.71
400.00	252.5	7.41	1213.09	276.09	138.05	207.05
420.00	251.5	7.81	1208.05	273.93	136.96	205.96
440.00	251.5	8.21	1208.05	272.91	136.45	205.45

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE S-302-A ,TESTED ON 28/02/1984 @ 7:30 PM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 3 PARTS PORTLAND CEMENT TYPE(V) + 8 PARTS WATER **
CONFINING PRESSURE = 69 KPA DRY DENSITY = 17.25 KN/M**3
WATER CONTENT AT TESTING = 7.327 % CURE PERIOD = 7 DAYS IN WAX
SAMPLE LENGTH= 14.72 CM SAMPLE AREA= 41.54 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	69.00
5.00	173.3	0.09	832.27	200.17	100.08	169.08
10.00	333.9	0.17	1604.00	385.44	192.72	261.72
15.00	451.5	0.26	2168.93	520.75	260.37	329.37
20.00	506.1	0.35	2431.22	583.22	291.61	360.61
25.00	530.3	0.43	2547.24	610.52	305.26	374.26
35.00	537.6	0.61	2582.54	617.91	308.95	377.95
40.00	535.5	0.70	2572.46	614.96	307.48	376.48
50.00	529.2	0.87	2542.19	606.67	303.33	372.33
60.00	519.8	1.05	2496.79	594.80	297.40	366.40
70.00	510.3	1.22	2451.40	582.97	291.48	360.48
80.00	499.8	1.40	2400.96	569.97	284.99	353.99
90.00	491.4	1.58	2360.61	559.41	279.71	348.71
100.00	481.9	1.76	2315.21	547.69	273.85	342.85
110.00	471.4	1.94	2264.77	534.82	267.41	336.41
120.00	462.0	2.11	2219.37	523.18	261.59	330.59
130.00	451.5	2.30	2168.93	510.39	255.19	324.19
140.00	441.0	2.48	2118.49	497.64	248.82	317.82
150.00	427.3	2.66	2052.92	481.38	240.69	309.69
160.00	410.6	2.84	1972.22	461.64	230.82	299.82
170.00	387.4	3.02	1861.25	434.89	217.44	286.44
180.00	362.3	3.21	1740.19	405.88	202.94	271.94
190.00	343.3	3.39	1649.40	384.02	192.01	261.01
200.00	324.4	3.58	1558.60	362.23	181.12	250.12
210.00	307.6	3.76	1477.90	342.86	171.43	240.43
220.00	290.8	3.95	1397.20	323.56	161.78	230.78
230.00	270.9	4.13	1301.36	300.83	150.41	219.41
240.00	256.2	4.32	1230.74	283.99	141.99	210.99
250.00	247.8	4.51	1190.39	274.18	137.09	206.09
260.00	243.6	4.70	1170.21	269.05	134.53	203.53
270.00	241.5	4.89	1160.13	266.25	133.12	202.12
280.00	242.0	5.08	1162.65	266.35	133.17	202.17
290.00	242.6	5.27	1165.17	266.44	133.22	202.22

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE S-401-A ,TESTED ON 24/03/1984 @ 10:00 AM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 4 PARTS PORTLAND CEMENT TYPE(V) + 8 PARTS WATER **
CONFINING PRESSURE = 69 KPA DRY DENSITY = 17.50 KN/M**3
WATER CONTENT AT TESTING = 6.986 % CURE PERIOD = 7 DAYS IN WAX
SAMPLE LENGTH= 14.69 CM SAMPLE AREA= 41.39 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	69.00
5.00	239.2	0.09	1149.08	277.37	138.69	207.69
10.00	457.6	0.17	2198.24	530.17	265.08	334.08
15.00	603.2	0.26	2897.68	698.25	349.13	418.12
20.00	676.0	0.35	3247.39	781.84	390.92	459:92
25.00	699.9	0.43	3362.30	808.81	404.40	473.40
30.00	706.2	0.52	3392.28	815.31	407.65	476.65
35.00	707.2	0.61	3397.27	815.80	407.90	476.90
45.00	704.1	0.78	3382.29	810.79	405.39	474.39
50.00	700.4	0.87	3364.80	805.89	402.95	471.95
55.00	696.3	0.96	3344.82	800.41	400.20	469.20
60.00	691.6	1.05	3322.33	794.34	397.17	466.17
70.00	681.2	1.22	3272.37	781.02	390.51	459.51
80.00	670.3	1.40	3219.92	767.16	383.58	452.58
90.00	659.4	1.58	3167.46	753.34	376.67	445.67
100.00	645.8	1.76	3102.51	736.60	368.30	437.30
110.00	626.1	1.94	3007.59	712.80	356.40	425.40
120.00	601.1	2.12	2887.68	683.18	341.59	410.59
130.00	572.0	2.30	2747.79	648.94	324.47	393.47
140.00	536.6	2.48	2577.93	607.74	303.87	372.87
150.00	483.6	2.66	2323.14	546.71	273.35	342.35
170.00	397.3	3.03	1908.47	447.53	223.76	292.76
180.00	267.3	3.21	1283.97	300.55	150.27	219.27
190.00	263.6	3.40	1266.48	295.93	147.96	216.96
200.00	269.4	3.58	1293.96	301.81	150.90	219.90
220.00	277.7	3.95	1333.93	310.02	155.01	224.01
230.00	281.8	4.14	1353.91	314.09	157.05	226.05
240.00	285.0	4.33	1368.90	317.00	158.50	227.50
250.00	288.1	4.52	1383.89	319.89	159.95	228.95
260.00	291.2	4.71	1398.88	322.77	161.39	230.39
270.00	293.3	4.90	1408.87	324.49	162.24	231.24
280.00	294.3	5.09	1413.86	325.05	162.52	231.52
290.00	294.8	5.28	1416.36	325.03	162.52	231.52

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE S-401-B ,TESTED ON 24/03/1984 @ 11:00 AM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 4 PARTS PORTLAND CEMENT TYPE(V) + 8 PARTS WATER **
CONFINING PRESSURE = 69 KPA DRY DENSITY = 17.49 KN/M**3
WATER CONTENT AT TESTING = 6.960 % CURE PERIOD = 7 DAYS IN WAX
SAMPLE LENGTH= 14.69 CM SAMPLE AREA= 41.31 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	69.00
5.00	222.6	0.09	1069.33	258.65	129.32	198.32
10.00	445.2	0.17	2138.67	516.85	258.42	327.42
15.00	572.4	0.26	2749.72	663.94	331.97	400.97
20.00	624.3	0.35	2999.23	723.56	361.78	430.78
25.00	660.4	0.43	3172.36	764.67	382.33	451.33
30.00	677.3	0.52	3253.83	783.62	391.81	460.81
35.00	684.8	0.61	3289.48	791.52	395.76	464.76
40.00	687.9	0.70	3304.75	794.50	397.25	466.25
45.00	688.5	0.78	3307.30	794.42	397.21	466.21
50.00	687.4	0.87	3302.21	792.51	396.25	465.25
55.00	684.8	0.96	3289.48	788.77	394.38	463.38
60.00	681.1	1.05	3271.65	783.81	391.90	460.90
70.00	673.1	1.22	3233.46	773.30	386.65	455.65
80.00	664.6	1.40	3192.73	762.23	381.11	450.11
90.00	655.1	1.58	3146.90	749.97	374.98	443.98
100.00	644.5	1.76	3095.98	736.54	368.27	437.27
110.00	633.9	1.94	3045.06	723.15	361.57	430.57
120.00	622.2	2.12	2989.04	708.60	354.30	423.30
130.00	604.2	2.30	2902.48	686.86	343.43	412.43
140.00	578.2	2.48	2777.72	656.17	328.09	397.09
150.00	542.7	2.66	2607.14	614.79	307.39	376.39
160.00	514.1	2.84	2469.65	581.33	290.67	359.67
170.00	468.5	3.03	2250.69	528.85	264.42	333.42
180.00	388.0	3.21	1863.70	437.14	218.57	287.57
190.00	328.6	3.40	1578.54	369.59	184.80	253.80
200.00	309.5	3.58	1486.88	347.51	173.75	242.75
210.00	304.8	3.77	1463.97	341.54	170.77	239.77
220.00	307.9	3.95	1479.25	344.49	172.24	241.24
230.00	310.6	4.14	1491.98	346.83	173.41	242.41
240.00	310.6	4.33	1491.98	346.20	173.10	242.10

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE S-102-A ,TESTED ON 19/03/1984 @ 1:00 PM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 1 PART PORTLAND CEMENT TYPE(V) + 8 PARTS WATER **
CONFINING PRESSURE = 69 KPA DRY DENSITY = 17.20 KN/M**3
WATER CONTENT AT TESTING = 7.577 % CURE PERIOD = 14 DAYS IN WAX
SAMPLE LENGTH= 14.72 CM SAMPLE AREA= 41.06 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	69.00
5.00	97.7	0.09	469.09	114.16	57.08	126.08
10.00	160.7	0.17	771.74	187.65	93.82	162.82
15.00	205.8	0.26	988.63	240.18	120.09	189.09
20.00	234.2	0.35	1124.82	273.03	136.51	205.51
25.00	256.2	0.43	1230.74	298.48	149.24	218.24
30.00	273.0	0.52	1311.45	317.78	158.89	227.89
40.00	296.6	0.69	1424.94	344.68	172.34	241.34
50.00	309.2	0.87	1485.47	358.69	179.35	248.35
55.00	313.4	0.96	1505.64	363.25	181.62	250.62
60.00	316.1	1.05	1518.25	365.97	182.99	251.99
70.00	320.3	1.22	1538.43	370.19	185.09	254.09
80.00	323.4	1.40	1553.56	373.18	186.59	255.59
100.00	326.0	1.76	1566.17	374.89	187.45	256.45
110.00	326.0	1.93	1566.17	374.23	187.12	256.12
120.00	326.0	2.11	1566.17	373.57	186.79	255.79
130.00	325.5	2.29	1563.65	372.32	186.16	255.16
140.00	324.4	2.48	1558.60	370.46	185.23	254.23
150.00	322.9	2.66	1551.04	368.01	184.00	253.00
160.00	321.3	2.84	1543.47	365.57	182.78	251.78
170.00	318.7	3.02	1530.86	361.94	180.97	249.97
180.00	316.6	3.20	1520.77	358.91	179.46	248.46
190.00	313.9	3.39	1508.17	355.30	177.65	246.65
200.00	310.8	3.57	1493.03	351.11	175.55	244.55
210.00	307.6	3.76	1477.90	346.93	173.47	242.46
220.00	304.0	3.95	1460.25	342.17	171.09	240.09
230.00	299.3	4.13	1437.55	336.25	168.12	237.12
240.00	291.9	4.32	1402.24	327.40	163.70	232.70
250.00	284.6	4.51	1366.93	318.58	159.29	228.29
260.00	274.1	4.70	1316.49	306.27	153.14	222.14
270.00	264.1	4.89	1268.57	294.59	147.30	216.30
280.00	256.7	5.08	1233.26	285.88	142.94	211.94
290.00	252.0	5.27	1210.57	280.11	140.05	209.05
300.00	250.4	5.46	1203.00	277.85	138.92	207.92
310.00	249.9	5.65	1200.48	276.76	138.38	207.38
320.00	250.4	5.84	1203.00	276.84	138.42	207.42
340.00	251.0	6.23	1205.52	276.41	138.20	207.20

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE S-301-A ,TESTED ON 06/03/1984 @ 11:00 AM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 3 PARTS PORTLAND CEMENT TYPE(V) + 8 PARTS WATER **
CONFINING PRESSURE = 69 KPA   DRY DENSITY = 17.34 KN/M**3
WATER CONTENT AT TESTING = 7.318 %   CURE PERIOD = 14 DAYS IN WAX
SAMPLE LENGTH= 14.72 CM   SAMPLE AREA= 41.49 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	69.00
5.00	205.8	0.09	988.63	238.08	119.04	188.04
10.00	386.4	0.17	1856.20	446.62	223.31	292.31
15.00	506.1	0.26	2431.22	584.47	292.23	361.23
20.00	558.6	0.35	2683.42	644.54	322.27	391.27
25.00	582.8	0.43	2799.44	671.82	335.91	404.91
30.00	590.1	0.52	2834.75	679.71	339.85	408.85
35.00	591.1	0.61	2839.79	680.33	340.16	409.16
40.00	590.1	0.69	2834.75	678.53	339.26	408.26
45.00	588.0	0.78	2824.66	675.53	337.76	406.76
50.00	585.9	0.87	2814.57	672.53	336.26	405.26
55.00	583.3	0.96	2801.96	668.93	334.47	403.47
60.00	581.2	1.05	2791.87	665.94	332.97	401.97
70.00	575.9	1.22	2766.65	658.78	329.39	398.39
80.00	571.2	1.40	2743.95	652.23	326.12	395.12
90.00	565.9	1.58	2718.73	645.11	322.55	391.55
100.00	559.6	1.76	2688.47	636.81	318.40	387.40
110.00	552.3	1.93	2653.16	627.34	313.67	382.67
120.00	543.9	2.11	2612.81	616.71	308.36	377.36
130.00	534.4	2.29	2567.41	604.93	302.47	371.47
140.00	523.9	2.47	2516.97	592.00	296.00	365.00
150.00	510.3	2.66	2451.40	575.56	287.78	356.78
160.00	488.3	2.84	2345.47	549.71	274.86	343.86
170.00	456.8	3.02	2194.15	513.33	256.67	325.67
180.00	425.3	3.20	2042.83	477.08	238.54	307.54
190.00	401.1	3.39	1926.82	449.19	224.59	293.59
200.00	374.8	3.57	1800.72	419.04	209.52	278.52
210.00	348.6	3.76	1674.62	389.00	194.50	263.50
220.00	329.7	3.94	1583.82	367.25	183.63	252.63
230.00	317.6	4.13	1525.82	353.17	176.58	245.58
240.00	312.9	4.32	1503.12	347.29	173.64	242.64
250.00	312.4	4.51	1500.60	346.08	173.04	242.04
260.00	312.9	4.70	1503.12	346.04	173.02	242.02
270.00	315.0	4.89	1513.21	347.73	173.87	242.87
280.00	316.1	5.08	1518.25	348.26	174.13	243.13
290.00	316.6	5.27	1520.77	348.21	174.10	243.10
300.00	319.2	5.46	1533.38	350.46	175.23	244.23
310.00	320.3	5.65	1538.43	350.97	175.48	244.48
320.00	320.3	5.84	1538.43	350.33	175.16	244.16

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE S-402-A ,TESTED ON 31/03/1984 @ 11:00 AM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 4 PARTS PORTLAND CEMENT TYPE(V) + 8 PARTS WATER **
CONFINING PRESSURE = 69 KPA DRY DENSITY = 17.59 KN/M**3
WATER CONTENT AT TESTING = 7.010 % CURE PERIOD = 14 DAYS IN WAX
SAMPLE LENGTH= 14.71 CM SAMPLE AREA= 41.50 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	69.00
5.00	210.0	0.09	1008.81	242.87	121.43	190.43
10.00	464.1	0.17	2229.46	536.27	268.13	337.13
15.00	664.6	0.26	3192.87	767.34	383.67	452.67
20.00	768.6	0.35	3692.23	886.58	443.29	512.29
25.00	816.9	0.43	3924.26	941.48	470.74	539.74
30.00	833.7	0.52	4004.96	960.01	480.01	549.00
35.00	837.4	0.61	4022.61	963.41	481.70	550.70
40.00	836.9	0.70	4020.09	961.97	480.98	549.98
45.00	832.7	0.78	3999.92	956.31	478.15	547.15
50.00	826.9	0.87	3972.17	948.85	474.42	543.42
55.00	820.1	0.96	3939.39	940.20	470.10	539.10
60.00	812.7	1.05	3904.08	930.96	465.48	534.48
70.00	798.5	1.22	3835.99	913.12	456.56	525.56
80.00	784.4	1.40	3767.89	895.35	447.67	516.67
90.00	769.6	1.58	3697.27	877.03	438.51	507.51
100.00	754.9	1.76	3626.66	858.77	429.38	498.38
110.00	714.0	1.94	3429.94	810.76	405.38	474.38
120.00	669.9	2.12	3218.09	759.35	379.67	448.67
130.00	618.4	2.30	2970.93	699.79	349.90	418.90
140.00	564.9	2.48	2713.69	638.07	319.03	388.03
150.00	518.7	2.66	2491.75	584.85	292.42	361.42
160.00	456.8	2.84	2194.15	514.09	257.04	326.04
170.00	381.1	3.02	1830.98	428.23	214.12	283.12
180.00	343.3	3.21	1649.40	385.08	192.54	261.54
190.00	331.3	3.39	1591.39	370.87	185.44	254.44
200.00	331.8	3.58	1593.91	370.80	185.40	254.40
210.00	336.0	3.76	1614.09	374.82	187.41	256.41
220.00	339.1	3.95	1629.22	377.66	188.83	257.83

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE S-403-A ,TESTED ON 16/04/1984 @ 11:00 AM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 4 PARTS PORTLAND CEMENT TYPE(V) + 8 PARTS WATER **
CONFINING PRESSURE = 69 KPA DRY DENSITY = 17.50 KN/M**3
WATER CONTENT AT TESTING = 7.074 % CURE PERIOD = 14 DAYS IN WAX
SAMPLE LENGTH= 14.72 CM SAMPLE AREA= 41.02 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	69.00
5.00	233.1	0.09	1119.78	272.77	136.39	205.39
10.00	462.0	0.17	2219.37	540.17	270.08	339.08
15.00	644.7	0.26	3097.03	753.12	376.56	445.56
20.00	764.4	0.35	3672.05	892.18	446.09	515.09
25.00	813.8	0.43	3909.12	948.96	474.48	543.48
30.00	827.4	0.52	3974.70	964.04	482.02	551.02
35.00	823.7	0.61	3957.04	958.93	479.46	548.46
40.00	813.8	0.70	3909.12	946.49	473.25	542.25
45.00	801.1	0.78	3848.59	931.03	465.51	534.51
50.00	789.6	0.87	3793.11	916.81	458.40	527.40
55.00	766.5	0.96	3682.14	889.21	444.60	513.60
60.00	745.5	1.05	3581.26	864.09	432.05	501.05
70.00	725.6	1.22	3485.43	839.50	419.75	488.75
80.00	706.6	1.40	3394.63	816.21	408.10	477.10
90.00	686.7	1.58	3298.80	791.78	395.89	464.89
100.00	666.8	1.76	3202.96	767.43	383.71	452.71
110.00	646.8	1.94	3107.12	743.16	371.58	440.58
120.00	624.8	2.12	3001.20	716.56	358.28	427.28
130.00	593.3	2.30	2849.88	679.23	339.61	408.61
140.00	562.8	2.48	2703.60	643.23	321.61	390.61
150.00	535.5	2.66	2572.46	610.94	305.47	374.47
160.00	513.4	2.84	2466.53	584.75	292.38	361.37
170.00	494.6	3.02	2375.74	562.23	281.11	350.11
180.00	481.4	3.21	2312.69	546.33	273.17	342.17
190.00	468.8	3.39	2252.16	531.08	265.54	334.54
200.00	458.8	3.58	2204.24	518.86	259.43	328.43
210.00	448.9	3.76	2156.32	506.67	253.34	322.34
220.00	437.8	3.95	2103.36	493.34	246.67	315.67
230.00	417.4	4.13	2005.00	469.43	234.71	303.71
240.00	399.0	4.32	1916.73	447.95	223.98	292.98
250.00	387.4	4.51	1861.25	434.20	217.10	286.10
260.00	381.7	4.70	1833.51	426.96	213.48	282.48
270.00	377.5	4.89	1813.33	421.50	210.75	279.75
280.00	374.8	5.08	1800.72	417.81	208.90	277.90
290.00	374.3	5.27	1798.20	416.47	208.23	277.23
300.00	374.3	5.46	1798.20	415.71	207.86	276.86
310.00	374.3	5.65	1798.20	414.95	207.48	276.48
320.00	375.4	5.85	1803.24	415.36	207.68	276.68
330.00	376.4	6.04	1808.28	415.76	207.88	276.88
340.00	377.5	6.23	1813.33	416.16	208.08	277.08
350.00	377.5	6.43	1813.33	415.39	207.70	276.70
360.00	376.4	6.63	1808.28	413.48	206.74	275.74

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE S-225-A ,TESTED ON 19/06/1984 @ 5:00 PM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 2 PARTS PORTLAND CEMENT TYPE(V) + 8 PARTS WATER **
CONFINING PRESSURE = 69 KPA DRY DENSITY = 16.15 KN/M**3
WATER CONTENT AT TESTING = 7.221 % CURE PERIOD = 14 DAYS IN WAX
SAMPLE LENGTH= 14.73 CM SAMPLE AREA= 41.45 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	69.00
5.00	82.6	0.09	396.65	95.62	47.81	116.81
10.00	174.3	0.17	837.37	201.69	100.84	169.84
15.00	247.7	0.26	1189.94	286.36	143.18	212.18
20.00	296.3	0.35	1423.52	342.28	171.14	240.14
25.00	322.0	0.43	1546.92	371.63	185.81	254.81
30.00	331.2	0.52	1590.99	381.88	190.94	259.94
35.00	333.5	0.61	1602.01	384.19	192.10	261.10
40.00	333.5	0.69	1602.01	383.86	191.93	260.93
45.00	332.6	0.78	1597.60	382.47	191.24	260.24
50.00	331.2	0.87	1590.99	380.56	190.28	259.28
55.00	330.3	0.96	1586.59	379.17	189.59	258.59
60.00	329.4	1.05	1582.18	377.79	188.90	257.90
70.00	327.5	1.22	1573.37	375.03	187.52	256.52
80.00	325.7	1.40	1564.55	372.28	186.14	255.14
90.00	323.9	1.58	1555.74	369.54	184.77	253.77
100.00	322.0	1.75	1546.92	366.80	183.40	252.40
110.00	320.6	1.93	1540.31	364.59	182.30	251.30
120.00	318.8	2.11	1531.50	361.87	180.93	249.93
130.00	317.4	2.29	1524.89	359.67	179.84	248.83
140.00	315.6	2.47	1516.07	356.96	178.48	247.48
150.00	313.8	2.66	1507.26	354.26	177.13	246.13
160.00	311.9	2.84	1498.44	351.56	175.78	244.78
170.00	310.1	3.02	1489.63	348.87	174.44	243.44
180.00	308.3	3.20	1480.81	346.19	173.10	242.10
190.00	306.0	3.39	1469.80	343.01	171.50	240.50
200.00	304.1	3.57	1460.98	340.34	170.17	239.17
210.00	301.8	3.76	1449.97	337.17	168.59	237.59
220.00	299.5	3.94	1438.95	334.01	167.01	236.01
230.00	297.2	4.13	1427.93	330.86	165.43	234.43
240.00	295.0	4.32	1416.91	327.72	163.86	232.86
250.00	292.2	4.51	1403.69	324.08	162.04	231.04
260.00	289.9	4.69	1392.67	320.95	160.48	229.48
270.00	287.2	4.88	1379.45	317.33	158.67	227.67
280.00	284.9	5.07	1368.43	314.23	157.11	226.11
290.00	282.1	5.26	1355.21	310.63	155.31	224.31
300.00	279.4	5.46	1341.99	307.04	153.52	222.52
310.00	277.1	5.65	1330.97	303.96	151.98	220.98
320.00	274.8	5.84	1319.95	300.90	150.45	219.45
340.00	269.7	6.23	1295.71	294.29	147.15	216.15
360.00	265.1	6.62	1273.68	288.23	144.11	213.11
380.00	261.5	7.01	1256.05	283.19	141.60	210.60
400.00	259.2	7.41	1245.03	279.67	139.84	208.84
420.00	257.3	7.81	1236.22	276.67	138.33	207.33
440.00	256.0	8.21	1229.61	274.16	137.08	206.08
460.00	255.0	8.62	1225.20	272.16	136.08	205.08
480.00	254.6	9.02	1222.99	270.65	135.33	204.33
500.00	255.0	9.44	1225.20	270.12	135.06	204.06

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE S-225-B ,TESTED ON 19/06/1984 @ 4:00 PM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 2 PARTS PORTLAND CEMENT TYPE(V) + 8 PARTS WATER **
CONFINING PRESSURE = 69 KPA   DRY DENSITY = 16.17 KN/M**3
WATER CONTENT AT TESTING = 7.313 %   CURE PERIOD = 14 DAYS IN WAX
SAMPLE LENGTH= 14.70 CM   SAMPLE AREA= 41.58 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	69.00
5.00	87.2	0.09	418.68	100.61	50.30	119.30
10.00	180.7	0.17	868.22	208.45	104.22	173.22
15.00	250.5	0.26	1203.16	288.61	144.31	213.31
20.00	295.4	0.35	1419.11	340.12	170.06	239.06
25.00	318.3	0.43	1529.29	366.21	183.10	252.10
30.00	325.7	0.52	1564.55	374.33	187.16	256.16
35.00	327.5	0.61	1573.37	376.11	188.05	257.05
40.00	327.5	0.70	1573.37	375.78	187.89	256.89
45.00	327.1	0.78	1571.16	374.93	187.46	256.46
50.00	326.6	0.87	1568.96	374.08	187.04	256.04
55.00	325.7	0.96	1564.55	372.70	186.35	255.35
60.00	324.8	1.05	1560.14	371.33	185.66	254.66
70.00	323.9	1.22	1555.74	369.63	184.82	253.82
80.00	322.5	1.40	1549.13	367.42	183.71	252.71
90.00	321.1	1.58	1542.52	365.21	182.60	251.60
100.00	319.3	1.76	1533.70	362.48	181.24	250.24
110.00	317.9	1.94	1527.09	360.29	180.14	249.14
120.00	316.5	2.12	1520.48	358.10	179.05	248.05
130.00	315.1	2.30	1513.87	355.91	177.96	246.95
140.00	313.3	2.48	1505.05	353.21	176.61	245.61
150.00	311.9	2.66	1498.44	351.04	175.52	244.52
160.00	310.1	2.84	1489.63	348.35	174.18	243.18
170.00	307.8	3.03	1478.61	345.16	172.58	241.58
180.00	306.0	3.21	1469.80	342.50	171.25	240.25
190.00	303.7	3.39	1458.78	339.32	169.66	238.66
200.00	301.8	3.58	1449.97	336.67	168.33	237.33
210.00	299.5	3.76	1438.95	333.51	166.76	235.76
220.00	297.2	3.95	1427.93	330.37	165.18	234.18
230.00	295.4	4.14	1419.11	327.74	163.87	232.87
240.00	293.1	4.33	1408.10	324.61	162.30	231.30
250.00	290.4	4.51	1394.87	320.98	160.49	229.49
260.00	288.1	4.70	1383.86	317.87	158.93	227.93
270.00	285.8	4.89	1372.84	314.77	157.38	226.38
280.00	283.5	5.08	1361.82	311.68	155.84	224.84
290.00	281.2	5.27	1350.80	308.59	154.30	223.30
300.00	278.4	5.47	1337.58	305.02	152.51	221.51
310.00	275.7	5.66	1324.36	301.45	150.73	219.73
320.00	273.4	5.85	1313.34	298.40	149.20	218.20
340.00	268.3	6.24	1289.10	291.82	145.91	214.91
360.00	263.3	6.63	1264.86	285.28	142.64	211.64
380.00	260.1	7.03	1249.44	280.76	140.38	209.38
400.00	257.3	7.42	1236.22	276.77	138.38	207.38
420.00	256.0	7.82	1229.61	274.26	137.13	206.13
440.00	254.6	8.23	1222.99	271.77	135.89	204.89
460.00	254.1	8.63	1220.79	270.27	135.13	204.13
480.00	254.1	9.04	1220.79	269.25	134.63	203.63
500.00	254.6	9.45	1222.99	268.72	134.36	203.36

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE S-226-A ,TESTED ON 19/06/1984 @ 8:00 PM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 2 PARTS PORTLAND CEMENT TYPE(V) + 8 PARTS WATER **
CONFINING PRESSURE = 69 KPA DRY DENSITY = 16.73 KN/M**3
WATER CONTENT AT TESTING = 7.324 % CURE PERIOD = 14 DAYS IN WAX
SAMPLE LENGTH= 14.70 CM SAMPLE AREA= 41.32 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	69.00
5.00	100.9	0.09	484.79	117.24	58.62	127.62
10.00	208.3	0.17	1000.43	241.72	120.86	189.86
15.00	300.9	0.26	1445.56	348.97	174.49	243.49
20.00	353.2	0.35	1696.77	409.26	204.63	273.63
25.00	378.0	0.43	1815.76	437.58	218.79	287.79
30.00	387.6	0.52	1862.04	448.35	224.17	293.17
35.00	390.4	0.61	1875.26	451.14	225.57	294.57
40.00	390.8	0.70	1877.46	451.28	225.64	294.64
45.00	390.8	0.78	1877.46	450.88	225.44	294.44
50.00	389.9	0.87	1873.05	449.43	224.72	293.72
55.00	389.4	0.96	1870.85	448.51	224.26	293.26
60.00	388.5	1.05	1866.45	447.07	223.53	292.53
70.00	387.2	1.22	1859.83	444.70	222.35	291.35
80.00	385.3	1.40	1851.02	441.82	220.91	289.91
90.00	383.5	1.58	1842.20	438.95	219.47	288.47
100.00	381.2	1.76	1831.19	435.56	217.78	286.78
110.00	378.9	1.94	1820.17	432.18	216.09	285.09
120.00	376.6	2.12	1809.15	428.80	214.40	283.40
130.00	374.3	2.30	1798.13	425.44	212.72	281.72
140.00	371.6	2.48	1784.91	421.57	210.78	279.78
150.00	368.8	2.66	1771.69	417.70	208.85	277.85
160.00	366.1	2.84	1758.47	413.85	206.93	275.93
170.00	363.3	3.03	1745.25	410.01	205.00	274.00
180.00	360.1	3.21	1729.82	405.66	202.83	271.83
190.00	356.9	3.39	1714.40	401.33	200.66	269.66
200.00	354.6	3.58	1703.38	398.04	199.02	268.02
210.00	350.5	3.76	1683.55	392.70	196.35	265.35
220.00	347.2	3.95	1668.12	388.40	194.20	263.20
230.00	343.6	4.14	1650.49	383.61	191.80	260.80
240.00	339.9	4.33	1632.86	378.83	189.41	258.41
250.00	336.2	4.51	1615.23	374.06	187.03	256.03
260.00	332.1	4.70	1595.40	368.80	184.40	253.40
270.00	327.5	4.89	1573.37	363.05	181.53	250.53
280.00	322.5	5.08	1549.13	356.81	178.41	247.41
290.00	317.9	5.27	1527.09	351.10	175.55	244.55
300.00	313.3	5.47	1505.05	345.40	172.70	241.70
310.00	308.7	5.66	1483.02	339.72	169.86	238.86
320.00	304.6	5.85	1463.19	334.57	167.28	236.28
340.00	298.2	6.24	1432.34	326.32	163.16	232.16
360.00	292.2	6.63	1403.69	318.62	159.31	228.31
380.00	288.5	7.03	1386.06	313.46	156.73	225.73
400.00	286.2	7.42	1375.04	309.81	154.91	223.91
420.00	285.3	7.82	1370.64	307.68	153.84	222.84
440.00	284.9	8.23	1368.43	306.04	153.02	222.02
460.00	284.9	8.63	1368.43	304.89	152.45	221.45
480.00	285.8	9.04	1372.84	304.73	152.36	221.36

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE S-226-B ,TESTED ON 19/06/1984 @ 9:00 PM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 2 PARTS PORTLAND CEMENT TYPE(V) + 8 PARTS WATER **
CONFINING PRESSURE = 69 KPA DRY DENSITY = 16.58 KN/M**3
WATER CONTENT AT TESTING = 7.333 % CURE PERIOD = 14 DAYS IN WAX
SAMPLE LENGTH= 14.70 CM SAMPLE AREA= 41.50 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	69.00
5.00	91.7	0.09	440.72	106.09	53.05	122.05
10.00	197.2	0.17	947.55	227.91	113.95	182.95
15.00	302.8	0.26	1454.37	349.51	174.75	243.75
20.00	348.6	0.35	1674.73	402.11	201.06	270.06
25.00	371.6	0.43	1784.91	428.20	214.10	283.10
30.00	379.4	0.52	1822.37	436.80	218.40	287.40
35.00	382.6	0.61	1837.80	440.12	220.06	289.06
40.00	383.0	0.70	1840.00	440.26	220.13	289.13
45.00	383.5	0.78	1842.20	440.41	220.20	289.20
50.00	382.6	0.87	1837.80	438.97	219.49	288.49
55.00	382.1	0.96	1835.59	438.06	219.03	288.03
60.00	381.2	1.05	1831.19	436.63	218.32	287.31
70.00	379.4	1.22	1822.37	433.77	216.89	285.88
80.00	377.5	1.40	1813.56	430.92	215.46	284.46
90.00	375.7	1.58	1804.74	428.07	214.04	283.04
100.00	373.9	1.76	1795.93	425.23	212.62	281.62
110.00	372.0	1.94	1787.11	422.40	211.20	280.20
120.00	370.2	2.12	1778.30	419.58	209.79	278.79
130.00	368.3	2.30	1769.49	416.76	208.38	277.38
140.00	366.1	2.48	1758.47	413.44	206.72	275.72
150.00	363.3	2.66	1745.25	409.60	204.80	273.80
160.00	361.0	2.84	1734.23	406.29	203.15	272.15
170.00	358.7	3.03	1723.21	402.99	201.50	270.50
180.00	356.0	3.21	1709.99	399.19	199.60	268.60
190.00	353.2	3.39	1696.77	395.40	197.70	266.70
200.00	350.5	3.58	1683.55	391.62	195.81	264.81
210.00	347.2	3.76	1668.12	387.33	193.67	262.67
220.00	344.5	3.95	1654.90	383.58	191.79	260.79
230.00	341.7	4.14	1641.68	379.83	189.91	258.91
240.00	338.5	4.33	1626.25	375.58	187.79	256.79
250.00	334.9	4.51	1608.62	370.84	185.42	254.42
260.00	331.2	4.70	1590.99	366.11	183.06	252.06
270.00	327.5	4.89	1573.37	361.40	180.70	249.70
280.00	323.4	5.08	1553.53	356.20	178.10	247.10
290.00	319.3	5.27	1533.70	351.02	175.51	244.51
300.00	315.1	5.47	1513.87	345.85	172.92	241.92
310.00	311.0	5.66	1494.04	340.69	170.35	239.35
320.00	306.9	5.85	1474.20	335.56	167.78	236.78
340.00	300.5	6.24	1443.35	327.33	163.67	232.67
360.00	295.9	6.63	1421.32	321.15	160.58	229.58
380.00	292.7	7.03	1405.89	316.50	158.25	227.25
400.00	290.4	7.42	1394.87	312.86	156.43	225.43
420.00	288.1	7.82	1383.86	309.23	154.62	223.62
440.00	287.2	8.23	1379.45	307.10	153.55	222.55
460.00	286.2	8.63	1375.04	304.97	152.49	221.49
480.00	286.2	9.04	1375.04	303.83	151.91	220.91
500.00	287.2	9.45	1379.45	303.65	151.83	220.83

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE S-221-A ,TESTED ON 28/05/1984 @ 10:00 AM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 2 PARTS PORTLAND CEMENT TYPE(V) + 8 PARTS WATER **
CONFINING PRESSURE = 69 KPA DRY DENSITY = 17.04 KN/M**3
WATER CONTENT AT TESTING = 7.350 % CURE PERIOD = 14 DAYS IN WAX
SAMPLE LENGTH= 14.71 CM SAMPLE AREA= 41.12 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	69.00
5.00	119.6	0.09	574.58	139.61	69.81	138.81
10.00	264.7	0.17	1271.60	308.71	154.35	223.35
15.00	357.8	0.26	1719.02	416.97	208.48	277.48
20.00	407.8	0.35	1959.21	474.82	237.41	306.41
25.00	430.4	0.43	2067.53	500.64	250.32	319.32
30.00	438.2	0.52	2105.21	509.32	254.66	323.66
35.00	441.7	0.61	2121.69	512.86	256.43	325.43
40.00	442.6	0.70	2126.40	513.55	256.78	325.78
45.00	442.6	0.78	2126.40	513.10	256.55	325.55
50.00	442.6	0.87	2126.40	512.66	256.33	325.33
55.00	442.2	0.96	2124.05	511.64	255.82	324.82
60.00	441.7	1.05	2121.69	510.63	255.32	324.32
70.00	440.2	1.22	2114.63	508.04	254.02	323.02
80.00	438.7	1.40	2107.56	505.46	252.73	321.73
90.00	436.8	1.58	2098.15	502.32	251.16	320.16
100.00	434.8	1.76	2088.73	499.19	249.59	318.59
110.00	432.4	1.94	2076.95	495.50	247.75	316.75
120.00	429.9	2.12	2065.18	491.83	245.91	314.91
130.00	427.0	2.30	2051.05	487.60	243.80	312.80
140.00	424.0	2.48	2036.92	483.39	241.69	310.69
150.00	420.6	2.66	2020.44	478.63	239.31	308.31
160.00	417.2	2.84	2003.95	473.88	236.94	305.94
170.00	413.2	3.02	1985.11	468.59	234.30	303.30
180.00	409.3	3.21	1966.28	463.32	231.66	300.66
190.00	404.9	3.39	1945.08	457.51	228.75	297.75
200.00	401.0	3.58	1926.24	452.27	226.13	295.13
210.00	396.1	3.76	1902.69	445.94	222.97	291.97
220.00	390.7	3.95	1876.79	439.08	219.54	288.54
230.00	385.3	4.14	1850.89	432.24	216.12	285.12
240.00	377.5	4.32	1813.21	422.68	211.34	280.34
250.00	368.6	4.51	1770.83	412.06	206.03	275.03
260.00	358.3	4.70	1721.37	399.83	199.91	268.91
270.00	351.0	4.89	1686.05	390.92	195.46	264.46
280.00	343.6	5.08	1650.73	382.03	191.02	260.02
290.00	337.3	5.27	1620.12	374.27	187.13	256.13
300.00	332.4	5.46	1596.57	368.16	184.08	253.08
320.00	327.0	5.85	1570.67	360.87	180.43	249.43
340.00	324.5	6.24	1558.89	356.85	178.43	247.43
360.00	323.0	6.63	1551.83	353.93	176.97	245.97
380.00	323.0	7.02	1551.83	352.63	176.31	245.31
400.00	323.5	7.42	1554.18	351.86	175.93	244.93
420.00	323.5	7.82	1554.18	350.55	175.28	244.28

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE S-221-B ,TESTED ON 28/05/1984 @ 11:00 AM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 2 PARTS PORTLAND CEMENT TYPE(V) + 8 PARTS WATER **
CONFINING PRESSURE = 69 KPA   DRY DENSITY = 16.91 KN/M**3
WATER CONTENT AT TESTING = 7.396 %   CURE PERIOD = 14 DAYS IN WAX
SAMPLE LENGTH= 14.71 CM   SAMPLE AREA= 41.80 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	69.00
5.00	88.2	0.09	423.87	101.31	50.65	119.65
10.00	205.9	0.17	989.03	236.18	118.09	187.09
15.00	299.0	0.26	1436.44	342.73	171.36	240.36
20.00	364.7	0.35	1751.99	417.65	208.83	277.83
25.00	403.9	0.43	1940.37	462.16	231.08	300.08
30.00	422.5	0.52	2029.85	483.05	241.53	310.53
35.00	430.9	0.61	2069.89	492.15	246.08	315.08
40.00	434.8	0.70	2088.73	496.20	248.10	317.10
45.00	436.8	0.78	2098.15	498.00	249.00	318.00
50.00	437.7	0.87	2102.86	498.69	249.34	318.34
55.00	438.2	0.96	2105.21	498.81	249.41	318.41
60.00	438.2	1.05	2105.21	498.38	249.19	318.19
70.00	438.2	1.22	2105.21	497.51	248.75	317.75
80.00	437.3	1.40	2100.50	495.53	247.76	316.76
90.00	435.3	1.58	2091.08	492.44	246.22	315.22
100.00	433.8	1.76	2084.02	489.92	244.96	313.96
110.00	431.9	1.94	2074.60	486.85	243.42	312.42
120.00	429.4	2.12	2062.82	483.23	241.62	310.62
130.00	427.0	2.30	2051.05	479.63	239.81	308.81
140.00	424.0	2.48	2036.92	475.48	237.74	306.74
150.00	421.1	2.66	2022.79	471.35	235.67	304.67
160.00	418.1	2.84	2008.66	467.23	233.61	302.61
170.00	414.2	3.02	1989.82	462.02	231.01	300.01
180.00	408.8	3.21	1963.92	455.20	227.60	296.60
190.00	406.4	3.39	1952.15	451.66	225.83	294.83
200.00	402.0	3.58	1930.95	445.96	222.98	291.98
210.00	397.1	3.76	1907.41	439.74	219.87	288.87
220.00	392.2	3.95	1883.86	433.53	216.76	285.76
230.00	385.3	4.13	1850.89	425.18	212.59	281.59
240.00	376.0	4.32	1806.15	414.15	207.08	276.08
250.00	365.7	4.51	1756.70	402.09	201.04	270.04
260.00	353.9	4.70	1700.18	388.45	194.23	263.23
270.00	344.1	4.89	1653.08	377.01	188.50	257.50
280.00	336.3	5.08	1615.41	367.75	183.87	252.87
290.00	329.9	5.27	1584.79	360.12	180.06	249.06
300.00	325.0	5.46	1561.25	354.13	177.06	246.06
310.00	323.0	5.65	1551.83	351.35	175.68	244.68
320.00	320.6	5.85	1540.05	348.05	174.02	243.02
340.00	320.6	6.24	1540.05	346.78	173.39	242.39
360.00	321.1	6.63	1542.41	346.03	173.02	242.02
380.00	322.1	7.02	1547.12	345.81	172.91	241.91

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE S-222-A ,TESTED ON 28/05/1984 @ 12:30 PM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 2 PARTS PORTLAND CEMENT TYPE(V) + 8 PARTS WATER **
CONFINING PRESSURE = 69 KPA DRY DENSITY = 17.30 KN/M**3
WATER CONTENT AT TESTING = 7.370 % CURE PERIOD = 14 DAYS IN WAX
SAMPLE LENGTH= 14.72 CM SAMPLE AREA= 41.51 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	69.00
5.00	163.7	0.09	786.51	189.32	94.66	163.66
10.00	324.5	0.17	1558.89	374.92	187.46	256.46
15.00	413.7	0.26	1987.47	477.58	238.79	307.79
20.00	461.8	0.35	2218.24	532.57	266.29	335.29
25.00	485.3	0.43	2331.27	559.23	279.61	348.61
30.00	498.0	0.52	2392.50	573.42	286.71	355.71
35.00	503.9	0.61	2420.76	579.69	289.84	358.84
40.00	508.3	0.69	2441.95	584.25	292.13	361.13
45.00	510.3	0.78	2451.37	586.00	293.00	362.00
50.00	511.3	0.87	2456.08	586.61	293.31	362.31
55.00	511.8	0.96	2458.43	586.66	293.33	362.33
60.00	511.8	1.05	2458.43	586.15	293.08	362.08
70.00	510.3	1.22	2451.37	583.45	291.73	360.73
80.00	508.8	1.40	2444.31	580.75	290.38	359.38
90.00	504.4	1.58	2423.11	574.71	287.36	356.36
100.00	502.9	1.76	2416.05	572.03	286.02	355.02
110.00	499.5	1.93	2399.56	567.13	283.57	352.57
120.00	495.1	2.11	2378.37	561.13	280.57	349.57
130.00	489.2	2.29	2350.11	553.49	276.74	345.74
140.00	481.9	2.47	2314.79	544.21	272.10	341.10
150.00	469.6	2.66	2255.92	529.43	264.72	333.72
160.00	452.9	2.84	2175.85	509.74	254.87	323.87
170.00	433.3	3.02	2081.66	486.80	243.40	312.40
180.00	411.8	3.20	1978.05	461.75	230.88	299.88
190.00	389.2	3.39	1869.73	435.69	217.84	286.84
200.00	359.8	3.57	1728.44	402.05	201.02	270.02
210.00	332.4	3.76	1596.57	370.71	185.35	254.35
220.00	312.7	3.94	1502.38	348.21	174.11	243.11
230.00	305.9	4.13	1469.41	339.96	169.98	238.98
240.00	305.9	4.32	1469.41	339.35	169.68	238.68
250.00	307.8	4.51	1478.83	340.91	170.46	239.46
260.00	309.8	4.70	1488.25	342.47	171.23	240.23

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE S-222-B ,TESTED ON 28/05/1984 @ 1:30 PM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 2 PARTS PORTLAND CEMENT TYPE(V) + 8 PARTS WATER **
CONFINING PRESSURE = 69 KPA DRY DENSITY = 17.39 KN/M**3
WATER CONTENT AT TESTING = 7.364 % CURE PERIOD = 14 DAYS IN WAX
SAMPLE LENGTH= 14.75 CM SAMPLE AREA= 40.85 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	69.00
5.00	125.5	0.09	602.83	147.46	73.73	142.73
10.00	266.7	0.17	1281.02	313.08	156.54	225.54
15.00	364.7	0.26	1751.99	427.82	213.91	282.91
20.00	421.6	0.35	2025.15	494.10	247.05	316.05
25.00	451.0	0.43	2166.43	528.11	264.06	333.06
30.00	467.6	0.52	2246.50	547.16	273.58	342.58
35.00	478.4	0.61	2298.31	559.29	279.64	348.64
40.00	483.3	0.69	2321.85	564.53	282.26	351.26
45.00	487.3	0.78	2340.69	568.62	284.31	353.31
50.00	489.2	0.87	2350.11	570.41	285.20	354.20
55.00	490.7	0.96	2357.18	571.63	285.81	354.81
60.00	491.2	1.04	2359.53	571.70	285.85	354.85
70.00	491.7	1.22	2361.89	571.28	285.64	354.64
80.00	491.7	1.40	2361.89	570.28	285.14	354.14
90.00	490.2	1.57	2354.82	567.58	283.79	352.79
100.00	488.2	1.75	2345.40	564.32	282.16	351.16
110.00	485.8	1.93	2333.63	560.51	280.25	349.25
120.00	482.8	2.11	2319.50	556.13	278.07	347.07
130.00	479.4	2.29	2303.01	551.21	275.61	344.61
140.00	475.5	2.47	2284.18	545.74	272.87	341.87
150.00	470.6	2.65	2260.63	539.16	269.58	338.58
160.00	466.2	2.83	2239.43	533.16	266.58	335.58
170.00	460.8	3.02	2213.53	526.06	263.03	332.03
180.00	454.9	3.20	2185.27	518.42	259.21	328.21
190.00	448.0	3.38	2152.31	509.70	254.85	323.85
200.00	441.2	3.57	2119.34	500.99	250.50	319.50
220.00	417.6	3.94	2006.31	472.58	236.29	305.29
230.00	402.0	4.12	1930.95	454.02	227.01	296.01
240.00	388.2	4.31	1865.02	437.73	218.86	287.86
250.00	374.5	4.50	1799.08	421.50	210.75	279.75
260.00	360.8	4.69	1733.15	405.32	202.66	271.66
270.00	350.0	4.88	1681.34	392.49	196.25	265.25
280.00	343.1	5.07	1648.37	384.10	192.05	261.05
290.00	336.8	5.26	1617.76	376.29	188.14	257.14
300.00	333.3	5.45	1601.28	371.78	185.89	254.89
310.00	331.9	5.64	1594.21	369.47	184.73	253.73
320.00	331.9	5.83	1594.21	368.79	184.40	253.40
340.00	333.3	6.22	1601.28	369.08	184.54	253.54
360.00	334.3	6.61	1605.99	368.81	184.40	253.40

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE S-223-A ,TESTED ON 09/06/1984 @ 12:30 PM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 2 PARTS PORTLAND CEMENT TYPE(V) + 8 PARTS WATER **
CONFINING PRESSURE = 69 KPA DRY DENSITY = 17.54 KN/M**3
WATER CONTENT AT TESTING = 7.247 % CURE PERIOD = 14 DAYS IN WAX
SAMPLE LENGTH= 14.70 CM SAMPLE AREA= 41.35 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	69.00
5.00	123.8	0.09	594.76	143.70	71.85	140.85
10.00	234.3	0.17	1125.47	271.68	135.84	204.84
15.00	329.5	0.26	1582.98	381.79	190.90	259.90
20.00	421.0	0.35	2022.19	487.30	243.65	312.65
25.00	473.3	0.43	2273.82	547.47	273.73	342.73
30.00	502.9	0.52	2415.64	581.11	290.55	359.55
35.00	516.2	0.61	2479.69	596.00	298.00	367.00
40.00	523.3	0.70	2514.01	603.72	301.86	370.86
45.00	526.2	0.78	2527.73	606.49	303.24	372.24
50.00	527.1	0.87	2532.31	607.06	303.53	372.53
55.00	527.1	0.96	2532.31	606.53	303.26	372.26
60.00	526.7	1.05	2530.02	605.45	302.73	371.73
70.00	524.3	1.22	2518.58	601.66	300.83	369.83
80.00	521.4	1.40	2504.86	597.34	298.67	367.67
90.00	518.1	1.58	2488.84	592.48	296.24	365.24
100.00	514.8	1.76	2472.83	587.63	293.82	362.82
110.00	511.0	1.94	2454.53	582.26	291.13	360.13
120.00	506.7	2.12	2433.94	576.36	288.18	357.18
130.00	502.4	2.30	2413.36	570.48	285.24	354.24
140.00	497.6	2.48	2390.48	564.07	282.03	351.03
150.00	491.9	2.66	2363.03	556.60	278.30	347.30
160.00	485.7	2.84	2333.29	548.62	274.31	343.31
170.00	478.6	3.03	2298.98	539.60	269.80	338.80
180.00	470.0	3.21	2257.80	528.99	264.49	333.49
190.00	460.5	3.39	2212.05	517.35	258.67	327.67
200.00	449.5	3.58	2159.44	504.14	252.07	321.07
210.00	434.3	3.76	2086.24	486.18	243.09	312.09
220.00	418.1	3.95	2008.46	467.21	233.61	302.61
230.00	404.8	4.14	1944.41	451.50	225.75	294.75
240.00	391.4	4.33	1880.36	435.84	217.92	286.92
250.00	381.4	4.51	1832.32	423.94	211.97	280.97
260.00	371.4	4.70	1784.28	412.08	206.04	275.04
270.00	360.0	4.89	1729.38	398.68	199.34	268.34
280.00	351.4	5.08	1688.20	388.48	194.24	263.24
290.00	343.3	5.27	1649.32	378.84	189.42	258.42
300.00	333.3	5.47	1601.28	367.14	183.57	252.57
310.00	321.0	5.66	1541.80	352.86	176.43	245.43
320.00	311.0	5.85	1493.76	341.24	170.62	239.62
340.00	303.8	6.24	1459.45	332.18	166.09	235.09
360.00	302.4	6.63	1452.59	329.41	164.70	233.70
380.00	303.3	7.03	1457.16	329.23	164.61	233.61
400.00	301.9	7.42	1450.30	326.47	163.23	232.23
420.00	303.3	7.82	1457.16	326.79	163.40	232.40
440.00	304.8	8.23	1464.03	327.11	163.55	232.55

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE S-223-B ,TESTED ON 09/06/1984 @ 1:30 PM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 2 PARTS PORTLAND CEMENT TYPE(V) + 8 PARTS WATER **
CONFINING PRESSURE = 69 KPA DRY DENSITY = 17.60 KN/M**3
WATER CONTENT AT TESTING = 7.375 % CURE PERIOD = 14 DAYS IN WAX
SAMPLE LENGTH= 14.71 CM SAMPLE AREA= 41.12 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	69.00
5.00	123.8	0.09	594.76	144.51	72.25	141.25
10.00	265.7	0.17	1276.45	309.87	154.93	223.93
15.00	371.4	0.26	1784.28	432.77	216.39	285.39
20.00	444.8	0.35	2136.56	517.77	258.88	327.88
25.00	485.7	0.43	2333.29	564.95	282.48	351.48
30.00	504.8	0.52	2424.79	586.60	293.30	362.30
35.00	514.3	0.61	2470.54	597.15	298.57	367.57
40.00	521.0	0.70	2502.57	604.36	302.18	371.18
45.00	524.3	0.78	2518.58	607.70	303.85	372.85
50.00	525.2	0.87	2523.16	608.28	304.14	373.14
55.00	525.7	0.96	2525.45	608.30	304.15	373.15
60.00	525.7	1.05	2525.45	607.77	303.88	372.88
70.00	524.8	1.22	2520.87	605.61	302.80	371.80
80.00	522.9	1.40	2511.72	602.35	301.18	370.18
90.00	520.0	1.58	2497.99	598.01	299.01	368.01
100.00	517.1	1.76	2484.27	593.69	296.84	365.84
110.00	513.8	1.94	2468.26	588.82	294.41	363.41
120.00	510.0	2.12	2449.96	583.43	291.71	360.71
130.00	505.7	2.30	2429.37	577.51	288.75	357.75
140.00	501.4	2.48	2408.78	571.60	285.80	354.80
150.00	496.2	2.66	2383.62	564.63	282.31	351.31
160.00	491.0	2.84	2358.46	557.68	278.84	347.84
170.00	484.8	3.02	2328.72	549.67	274.83	343.83
180.00	478.1	3.21	2296.69	541.14	270.57	339.57
190.00	469.5	3.39	2255.52	530.50	265.25	334.25
200.00	451.4	3.58	2168.59	509.14	254.57	323.57
210.00	434.3	3.76	2086.24	488.93	244.46	313.46
220.00	416.2	3.95	1999.31	467.72	233.86	302.86
230.00	402.9	4.13	1935.26	451.92	225.96	294.96
240.00	391.4	4.32	1880.36	438.31	219.16	288.16
250.00	380.0	4.51	1825.46	424.75	212.37	281.37
260.00	369.0	4.70	1772.84	411.76	205.88	274.88
270.00	362.4	4.89	1740.82	403.59	201.80	270.80
280.00	358.1	5.08	1720.23	398.10	199.05	268.05
290.00	353.3	5.27	1697.36	392.09	196.05	265.05
300.00	350.5	5.46	1683.63	388.21	194.11	263.11
310.00	347.1	5.65	1667.62	383.82	191.91	260.91
320.00	346.2	5.85	1663.04	382.07	191.03	260.03
340.00	344.3	6.24	1653.89	378.58	189.29	258.29
360.00	343.8	6.63	1651.60	376.67	188.33	257.33
380.00	342.4	7.02	1644.74	373.72	186.86	255.86
400.00	340.0	7.42	1633.30	369.75	184.88	253.88
420.00	337.6	7.82	1621.87	365.80	182.90	251.90
440.00	330.0	8.22	1585.27	356.22	178.11	247.11
460.00	314.3	8.63	1509.78	337.98	168.99	237.99
480.00	311.4	9.04	1496.05	333.66	166.83	235.83
500.00	310.5	9.45	1491.48	331.38	165.69	234.69
520.00	311.4	9.86	1496.05	331.14	165.57	234.57

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE R-203-A ,TESTED ON 27/03/1984 @ 8:30 AM **
** COMPOSITION OF MIX(BY WEIGHT)= 102 PARTS USED UP SAMPLES
(PULVERIZED AND RECOPACTED, ORIGINALLY MIXED WITH
2 PARTS PORTLAND CEMENT TYPE(5))+ 8 PARTS WATER **
CONFINING PRESSURE = 69 KPA DRY DENSITY = 17.01 KN/M**3
WATER CONTENT AT TESTING = N.A. CURE PERIOD = 7 DAYS IN WAX
SAMPLE LENGTH= 14.69 CM SAMPLE AREA= 40.75 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	69.00
5.00	63.0	0.09	302.64	74.20	37.10	106.10
10.00	98.0	0.17	470.78	115.31	57.66	126.66
15.00	127.0	0.26	610.09	149.31	74.65	143.65
20.00	150.0	0.35	720.58	176.20	88.10	157.10
25.00	168.5	0.43	809.45	197.76	98.88	167.88
30.00	184.0	0.52	883.91	215.76	107.88	176.88
35.00	194.0	0.61	931.94	227.29	113.64	182.64
40.00	203.0	0.70	975.18	237.63	118.81	187.81
45.00	208.0	0.78	999.20	243.27	121.63	190.63
50.00	212.5	0.87	1020.82	248.31	124.16	193.16
55.00	216.0	0.96	1037.63	252.18	126.09	195.09
60.00	219.0	1.05	1052.04	255.46	127.73	196.73
70.00	222.5	1.22	1068.85	259.09	129.55	198.55
80.00	225.5	1.40	1083.27	262.13	131.06	200.06
90.00	227.5	1.58	1092.87	263.99	131.99	200.99
100.00	229.5	1.76	1102.48	265.84	132.92	201.92
110.00	231.0	1.94	1109.69	267.11	133.55	202.55
120.00	232.0	2.12	1114.49	267.79	133.89	202.89
130.00	233.0	2.30	1119.29	268.47	134.23	203.23
140.00	233.5	2.48	1121.70	268.57	134.28	203.28
150.00	234.0	2.66	1124.10	268.67	134.33	203.33
160.00	234.5	2.84	1126.50	268.76	134.38	203.38
170.00	234.5	3.03	1126.50	268.29	134.14	203.14
180.00	234.5	3.21	1126.50	267.81	133.90	202.90
190.00	235.0	3.40	1128.90	267.90	133.95	202.95
200.00	235.0	3.58	1128.90	267.42	133.71	202.71
210.00	235.0	3.77	1128.90	266.94	133.47	202.47
220.00	234.5	3.95	1126.50	265.90	132.95	201.95
230.00	234.0	4.14	1124.10	264.85	132.43	201.43
240.00	234.0	4.33	1124.10	264.38	132.19	201.19
250.00	233.5	4.52	1121.70	263.34	131.67	200.67
260.00	233.5	4.71	1121.70	262.86	131.43	200.43
270.00	233.0	4.90	1119.29	261.82	130.91	199.91
280.00	232.5	5.09	1116.89	260.79	130.39	199.39
290.00	232.5	5.28	1116.89	260.31	130.16	199.16
300.00	232.0	5.47	1114.49	259.28	129.64	198.64
320.00	230.0	5.86	1104.88	256.11	128.05	197.05
340.00	230.0	6.25	1104.88	255.17	127.59	196.58
360.00	230.0	6.64	1104.88	254.23	127.12	196.12
380.00	229.0	7.03	1100.08	252.19	126.10	195.10
400.00	227.5	7.43	1092.87	249.61	124.81	193.81
420.00	226.5	7.83	1088.07	247.59	123.80	192.80
440.00	226.0	8.23	1085.67	246.13	123.06	192.06
460.00	225.0	8.64	1080.86	244.12	122.06	191.06
480.00	224.5	9.05	1078.46	242.66	121.33	190.33
500.00	224.0	9.46	1076.06	241.21	120.60	189.60
520.00	224.0	9.88	1076.06	240.30	120.15	189.15
540.00	224.0	10.30	1076.06	239.38	119.69	188.69
560.00	224.5	10.72	1078.46	239.00	119.50	188.50
580.00	225.0	11.14	1080.86	238.62	119.31	188.31
600.00	226.0	11.57	1085.67	238.76	119.38	188.38
640.00	227.5	12.44	1092.87	238.49	119.24	188.24
660.00	228.0	12.88	1095.28	238.08	119.04	188.04
680.00	228.5	13.32	1097.68	237.67	118.84	187.84
700.00	228.5	13.77	1097.68	236.74	118.37	187.37
740.00	230.0	14.67	1104.88	236.42	118.21	187.21
780.00	231.5	15.59	1112.09	236.08	118.04	187.04
820.00	233.0	16.52	1119.29	235.71	117.85	186.85
840.00	234.0	16.99	1124.10	235.77	117.88	186.88

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE R-203-B ,TESTED ON 27/03/1984 @ 09:30 AM **
** COMPOSITION OF MIX(BY WEIGHT)= 102 PARTS USED UP SAMPLES
(PULVERIZED AND RECOPACTED, ORIGINALLY MIXED WITH
2 PARTS PORTLAND CEMENT TYPE(5))+ 8 PARTS WATER **

CONFINING PRESSURE = 69 KPA DRY DENSITY = 17.09 KN/M**3
WATER CONTENT AT TESTING = 7.294 % CURE PERIOD = 7 DAYS IN WAX
SAMPLE LENGTH= 14.71 CM SAMPLE AREA= 41.25 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	69.00
5.00	65.0	0.09	312.25	75.64	37.82	106.82
10.00	106.0	0.17	509.21	123.24	61.62	130.62
15.00	135.0	0.26	648.52	156.82	78.41	147.41
20.00	157.0	0.35	754.20	182.22	91.11	160.11
25.00	177.0	0.43	850.28	205.25	102.63	171.63
30.00	193.0	0.52	927.14	223.61	111.81	180.81
35.00	203.0	0.61	975.18	235.00	117.50	186.50
40.00	211.0	0.70	1013.61	244.04	122.02	191.02
45.00	217.0	0.78	1042.43	250.77	125.38	194.38
50.00	221.5	0.87	1064.05	255.74	127.87	196.87
55.00	225.0	0.96	1080.86	259.56	129.78	198.78
60.00	227.5	1.05	1092.87	262.21	131.11	200.11
70.00	232.0	1.22	1114.49	266.93	133.47	202.47
80.00	234.5	1.40	1126.50	269.34	134.67	203.67
90.00	236.5	1.58	1136.11	271.16	135.58	204.58
100.00	238.0	1.76	1143.31	272.40	136.20	205.20
110.00	239.5	1.94	1150.52	273.64	136.82	205.82
120.00	240.0	2.12	1152.92	273.72	136.86	205.86
130.00	240.5	2.30	1155.32	273.81	136.91	205.91
140.00	241.0	2.48	1157.72	273.90	136.95	205.95
150.00	241.5	2.66	1160.13	273.98	136.99	205.99
160.00	241.5	2.84	1160.13	273.49	136.75	205.75
170.00	242.0	3.02	1162.53	273.57	136.79	205.79
180.00	242.0	3.21	1162.53	273.09	136.54	205.54
190.00	242.0	3.39	1162.53	272.60	136.30	205.30
200.00	241.5	3.58	1160.13	271.55	135.78	204.77
210.00	241.5	3.76	1160.13	271.06	135.53	204.53
220.00	241.0	3.95	1157.72	270.02	135.01	204.01
230.00	240.5	4.14	1155.32	268.97	134.49	203.49
240.00	240.0	4.32	1152.92	267.93	133.97	202.97
250.00	240.0	4.51	1152.92	267.45	133.73	202.72
270.00	238.5	4.89	1145.72	264.82	132.41	201.41
280.00	238.0	5.08	1143.31	263.79	131.89	200.89
290.00	237.5	5.27	1140.91	262.75	131.38	200.38
300.00	237.0	5.46	1138.51	261.72	130.86	199.86
310.00	236.5	5.66	1136.11	260.70	130.35	199.35
320.00	235.5	5.85	1131.30	259.12	129.56	198.56
340.00	234.0	6.24	1124.10	256.53	128.26	197.26
360.00	232.5	6.63	1116.89	253.95	126.97	195.97
380.00	231.5	7.02	1112.09	251.93	125.96	194.96
400.00	230.5	7.42	1107.28	249.91	124.96	193.96
420.00	229.5	7.82	1102.48	247.90	123.95	192.95
440.00	228.5	8.22	1097.68	245.90	122.95	191.95
460.00	228.5	8.63	1097.68	244.99	122.49	191.49
500.00	228.0	9.45	1095.28	242.61	121.31	190.31
540.00	228.0	10.28	1095.28	240.78	120.39	189.39
580.00	228.5	11.13	1097.68	239.47	119.74	188.74
620.00	230.0	11.99	1104.88	239.19	119.60	188.60
660.00	232.0	12.86	1114.49	239.41	119.70	188.70
700.00	233.0	13.75	1119.29	238.56	119.28	188.28
740.00	234.5	14.65	1126.50	238.21	119.11	188.11
780.00	236.0	15.56	1133.71	237.84	118.92	187.92
820.00	238.0	16.49	1143.31	237.94	118.97	187.97
840.00	239.0	16.97	1148.12	237.98	118.99	187.99

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE R-204-A ,TESTED ON 04/04/1984 @ 1:00 PM **
** COMPOSITION OF MIX(BY WEIGHT)= 102 PARTS USED UP SAMPLES
(PULVERIZED AND RECOPACTED, ORIGINALLY MIXED WITH
2 PARTS PORTLAND CEMENT TYPE(5))+ 8 PARTS WATER **
CONFINING PRESSURE = 69 KPA DRY DENSITY = 16.92 KN/M**3
WATER CONTENT AT TESTING = 7.282 % CURE PERIOD = 14 DAYS IN WAX
SAMPLE LENGTH= 14.73 CM SAMPLE AREA= 41.29 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	69.00
5.00	60.0	0.09	288.23	69.75	34.88	103.88
10.00	95.0	0.17	456.36	110.34	55.17	124.17
15.00	127.0	0.26	610.09	147.38	73.69	142.69
20.00	152.0	0.35	730.18	176.24	88.12	157.12
25.00	173.0	0.43	831.06	200.42	100.21	169.21
30.00	190.0	0.52	912.73	219.92	109.96	178.96
35.00	203.0	0.61	975.18	234.77	117.38	186.38
40.00	212.5	0.69	1020.82	245.54	122.77	191.77
45.00	219.0	0.78	1052.04	252.83	126.42	195.42
50.00	223.5	0.87	1073.66	257.80	128.90	197.90
55.00	227.5	0.96	1092.87	262.19	131.09	200.09
60.00	231.0	1.05	1109.69	265.99	132.99	201.99
70.00	235.5	1.22	1131.30	270.70	135.35	204.35
80.00	239.0	1.40	1148.12	274.24	137.12	206.12
90.00	241.5	1.58	1160.13	276.62	138.31	207.31
100.00	243.5	1.76	1169.73	278.43	139.21	208.21
110.00	244.5	1.93	1174.54	279.08	139.54	208.54
120.00	246.0	2.11	1181.74	280.30	140.15	209.15
130.00	246.5	2.29	1184.15	280.37	140.19	209.19
140.00	247.0	2.47	1186.55	280.45	140.22	209.22
150.00	247.5	2.66	1188.95	280.52	140.26	209.26
160.00	248.0	2.84	1191.35	280.59	140.29	209.29
170.00	248.0	3.02	1191.35	280.09	140.04	209.04
180.00	248.0	3.20	1191.35	279.59	139.80	208.80
190.00	248.0	3.39	1191.35	279.09	139.55	208.55
200.00	247.5	3.57	1188.95	278.03	139.02	208.02
210.00	247.5	3.76	1188.95	277.54	138.77	207.77
220.00	247.0	3.94	1186.55	276.48	138.24	207.24
230.00	246.5	4.13	1184.15	275.43	137.71	206.71
240.00	246.0	4.32	1181.74	274.37	137.19	206.19
250.00	245.0	4.51	1176.94	272.77	136.38	205.38
260.00	244.5	4.69	1174.54	271.72	135.86	204.86
270.00	244.0	4.88	1172.14	270.67	135.34	204.34
280.00	243.0	5.07	1167.33	269.08	134.54	203.54
290.00	242.5	5.27	1164.93	268.04	134.02	203.02
300.00	242.0	5.46	1162.53	267.00	133.50	202.50
310.00	241.5	5.65	1160.13	265.96	132.98	201.98
320.00	241.0	5.84	1157.72	264.93	132.46	201.46
340.00	240.0	6.23	1152.92	262.87	131.43	200.43
360.00	239.0	6.62	1148.12	260.81	130.41	199.41
380.00	237.0	7.01	1138.51	257.68	128.84	197.84
400.00	236.0	7.41	1133.71	255.64	127.82	196.82
420.00	234.5	7.81	1126.50	253.08	126.54	195.54
440.00	233.5	8.21	1121.70	251.06	125.53	194.53
460.00	232.5	8.62	1116.89	249.05	124.53	193.53
480.00	231.5	9.03	1112.09	247.05	123.53	192.53
500.00	231.5	9.44	1112.09	246.12	123.06	192.06
520.00	231.0	9.85	1109.69	244.66	122.33	191.33
540.00	231.0	10.27	1109.69	243.74	121.87	190.87
560.00	230.5	10.69	1107.28	242.29	121.14	190.14
580.00	230.5	11.12	1107.28	241.36	120.68	189.68
600.00	230.0	11.54	1104.88	239.91	119.96	188.96
620.00	230.0	11.97	1104.88	238.99	119.50	188.50
640.00	229.5	12.41	1102.48	237.55	118.77	187.77
660.00	229.0	12.85	1100.08	236.11	118.06	187.06
680.00	229.0	13.29	1100.08	235.19	117.60	186.60
700.00	229.0	13.73	1100.08	234.27	117.14	186.14
720.00	229.0	14.18	1100.08	233.36	116.68	185.68

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE C-201-A ,TESTED ON 15/04/1984 @ 11:30 AM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 2 PARTS CALCIUM CARBONATE + 8 PARTS WATER **

CONFINING PRESSURE = 69 KPA DRY DENSITY = 17.39 KN/M**3
WATER CONTENT AT TESTING=7.694% CURE PERIOD= 7 DAYS IN WAX
SAMPLE LENGTH= 14.71 CM SAMPLE AREA= 41.12 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	69.00
5.00	72.0	0.09	345.88	84.04	42.02	111.02
10.00	106.0	0.17	509.21	123.61	61.81	130.81
15.00	131.0	0.26	629.30	152.64	76.32	145.32
20.00	147.0	0.35	706.16	171.13	85.56	154.56
25.00	165.0	0.43	792.63	191.92	95.96	164.96
30.00	179.0	0.52	859.89	208.02	104.01	173.01
35.00	186.0	0.61	893.51	215.97	107.98	176.98
40.00	194.0	0.70	931.94	225.06	112.53	181.53
45.00	199.0	0.78	955.96	230.66	115.33	184.33
50.00	203.0	0.87	975.18	235.09	117.55	186.55
55.00	206.0	0.96	989.59	238.36	119.18	188.18
60.00	208.0	1.05	999.20	240.46	120.23	189.23
70.00	212.0	1.22	1018.41	244.66	122.33	191.33
80.00	214.0	1.40	1028.02	246.54	123.27	192.27
90.00	215.0	1.58	1032.83	247.26	123.63	192.63
100.00	215.0	1.76	1032.83	246.82	123.41	192.41
110.00	216.0	1.94	1037.63	247.54	123.77	192.77
120.00	216.0	2.12	1037.63	247.10	123.55	192.55
130.00	216.0	2.30	1037.63	246.66	123.33	192.33
140.00	215.0	2.48	1032.83	245.09	122.54	191.54
150.00	214.0	2.66	1028.02	243.52	121.76	190.76
160.00	214.0	2.84	1028.02	243.09	121.54	190.54
170.00	213.0	3.02	1023.22	241.52	120.76	189.76
180.00	213.0	3.21	1023.22	241.09	120.55	189.55
190.00	212.0	3.39	1018.41	239.53	119.77	188.77
200.00	212.0	3.58	1018.41	239.10	119.55	188.55
210.00	211.0	3.76	1013.61	237.55	118.78	187.78
220.00	210.0	3.95	1008.81	236.00	118.00	187.00
230.00	210.0	4.13	1008.81	235.58	117.79	186.79
240.00	209.0	4.32	1004.00	234.03	117.02	186.02
250.00	208.0	4.51	999.20	232.49	116.25	185.25
260.00	208.0	4.70	999.20	232.08	116.04	185.04
270.00	207.0	4.89	994.39	230.54	115.27	184.27
280.00	206.0	5.08	989.59	229.01	114.51	183.51
290.00	206.0	5.27	989.59	228.60	114.30	183.30
300.00	205.0	5.46	984.79	227.07	113.54	182.54
310.00	204.0	5.65	979.98	225.56	112.78	181.78
320.00	203.0	5.85	975.18	224.04	112.02	181.02
340.00	201.0	6.24	965.57	221.02	110.51	179.51
360.00	200.0	6.63	960.77	219.12	109.56	178.56
380.00	198.0	7.02	951.16	216.13	108.06	177.06
400.00	198.0	7.42	951.16	215.33	107.66	176.66
420.00	197.0	7.82	946.36	213.45	106.72	175.72
440.00	196.0	8.22	941.55	211.57	105.79	174.79
460.00	196.0	8.63	941.55	210.78	105.39	174.39
500.00	196.5	9.45	943.95	209.73	104.87	173.87

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE C-201-B ,TESTED ON 15/04/1984 @ 1:00 PM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 2 PARTS CALCIUM CARBONATE + 8 PARTS WATER **

CONFINING PRESSURE = 69 KPA   DRY DENSITY = 17.26 KN/M**3
WATER CONTENT AT TESTING=7.551%   CURE PERIOD= 7 DAYS IN WAX
SAMPLE LENGTH= 14.69 CM   SAMPLE AREA= 41.29 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	69.00
5.00	70.0	0.09	336.27	81.37	40.69	109.69
10.00	102.0	0.17	489.99	118.47	59.24	128.24
15.00	129.0	0.26	619.70	149.70	74.85	143.85
20.00	149.0	0.35	715.77	172.76	86.38	155.38
25.00	167.0	0.43	802.24	193.47	96.73	165.73
30.00	181.0	0.52	869.49	209.50	104.75	173.75
35.00	189.0	0.61	907.93	218.57	109.29	178.29
40.00	196.5	0.70	943.95	227.05	113.52	182.52
45.00	201.5	0.78	967.97	232.62	116.31	185.31
50.00	205.0	0.87	984.79	236.46	118.23	187.23
55.00	208.5	0.96	1001.60	240.28	120.14	189.14
60.00	210.5	1.05	1011.21	242.38	121.19	190.19
70.00	214.0	1.23	1028.02	245.98	122.99	191.99
80.00	216.0	1.40	1037.63	247.84	123.92	192.92
90.00	217.5	1.58	1044.83	249.12	124.56	193.56
100.00	218.5	1.76	1049.64	249.83	124.91	193.91
110.00	219.5	1.94	1054.44	250.53	125.27	194.27
120.00	219.0	2.12	1052.04	249.52	124.76	193.76
130.00	219.0	2.30	1052.04	249.08	124.54	193.54
140.00	219.0	2.48	1052.04	248.64	124.32	193.32
150.00	219.0	2.66	1052.04	248.20	124.10	193.10
160.00	218.5	2.85	1049.64	247.19	123.60	192.60
170.00	217.0	3.03	1042.43	245.06	122.53	191.53
180.00	216.5	3.21	1040.03	244.06	122.03	191.03
190.00	215.5	3.40	1035.23	242.50	121.25	190.25
200.00	215.0	3.58	1032.83	241.50	120.75	189.75
210.00	214.5	3.77	1030.42	240.51	120.25	189.25
220.00	213.5	3.96	1025.62	238.96	119.48	188.48
230.00	213.0	4.14	1023.22	237.97	118.98	187.98
240.00	212.0	4.33	1018.41	236.43	118.21	187.21
250.00	211.5	4.52	1016.01	235.44	117.72	186.72
260.00	211.0	4.71	1013.61	234.46	117.23	186.23
270.00	210.0	4.90	1008.81	232.93	116.46	185.46
280.00	209.5	5.09	1006.40	231.95	115.98	184.98
290.00	209.0	5.28	1004.00	230.98	115.49	184.49
300.00	208.0	5.47	999.20	229.45	114.73	183.73
310.00	207.5	5.66	996.80	228.48	114.24	183.24
320.00	206.5	5.86	991.99	226.97	113.48	182.48
340.00	204.5	6.25	982.39	223.95	111.97	180.97
360.00	203.0	6.64	975.18	221.49	110.74	179.74
380.00	201.5	7.03	967.97	219.04	109.52	178.52
400.00	201.0	7.43	965.57	217.69	108.84	177.84
420.00	200.0	7.83	960.77	215.80	107.90	176.90
440.00	199.5	8.24	958.37	214.46	107.23	176.23
460.00	199.0	8.64	955.96	213.12	106.56	175.56
500.00	199.5	9.47	958.37	212.05	106.02	175.02
540.00	200.5	10.30	963.17	211.50	105.75	174.75
580.00	202.0	11.15	970.38	211.45	105.73	174.73
620.00	204.0	12.01	979.98	211.91	105.95	174.95
660.00	207.0	12.88	994.39	213.36	106.68	175.68

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE C-202-A ,TESTED ON 23/04/1984 @ 8:00 AM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 2 PARTS CALCIUM CARBONATE + 8 PARTS WATER **
CONFINING PRESSURE = 69 KPA DRY DENSITY = 17.48 KN/M**3
WATER CONTENT AT TESTING= 7.689 CURE PERIOD=14 DAYS IN WAX
SAMPLE LENGTH= 14.73 CM SAMPLE AREA= 40.83 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.	0.00	0.00	0.00	0.00	69.00
5.00	75.	0.09	360.29	88.17	44.08	113.08
10.00	110.	0.17	528.42	129.20	64.60	133.60
15.00	140.	0.26	672.54	164.29	82.15	151.15
20.00	159.	0.35	763.81	186.43	93.22	162.22
25.00	174.	0.43	835.87	203.84	101.92	170.92
30.00	183.	0.52	879.10	214.20	107.10	176.10
35.00	193.	0.61	927.14	225.71	112.85	181.85
40.00	199.	0.69	955.96	232.52	116.26	185.26
45.00	204.	0.78	977.58	237.58	118.79	187.79
50.00	207.	0.87	994.39	241.45	120.73	189.73
55.00	210.	0.96	1008.81	244.74	122.37	191.37
60.00	213.	1.05	1020.82	247.44	123.72	192.72
70.00	216.	1.22	1037.63	251.07	125.54	194.54
80.00	218.	1.40	1047.24	252.96	126.48	195.48
90.00	220.	1.58	1054.44	254.25	127.13	196.13
100.00	221.	1.75	1059.25	254.96	127.48	196.48
110.00	221.	1.93	1061.65	255.09	127.55	196.55
120.00	221.	2.11	1061.65	254.64	127.32	196.32
130.00	221.	2.29	1061.65	254.20	127.10	196.10
140.00	221.	2.47	1061.65	253.75	126.87	195.87
150.00	221.	2.66	1061.65	253.30	126.65	195.65
160.00	221.	2.84	1059.25	252.28	126.14	195.14
170.00	220.	3.02	1056.84	251.26	125.63	194.63
180.00	219.	3.20	1052.04	249.67	124.84	193.84
190.00	218.	3.39	1047.24	248.09	124.05	193.05
200.00	217.	3.57	1042.43	246.51	123.26	192.26
210.00	217.	3.76	1040.03	245.51	122.75	191.75
220.00	215.	3.94	1032.83	243.37	121.68	190.68
230.00	214.	4.13	1028.02	241.80	120.90	189.90
240.00	213.	4.32	1023.22	240.24	120.12	189.12
250.00	212.	4.50	1016.01	238.12	119.06	188.06
260.00	211.	4.69	1011.21	236.57	118.28	187.28
270.00	210.	4.88	1006.40	235.02	117.51	186.51
280.00	209.	5.07	1001.60	233.47	116.74	185.74
290.00	208.	5.26	996.80	231.93	115.97	184.97
300.00	207.	5.45	991.99	230.40	115.20	184.20
310.00	206.	5.65	987.19	228.86	114.43	183.43
320.00	205.	5.84	982.39	227.33	113.67	182.67
340.00	203.	6.23	975.18	224.84	112.42	181.42
360.00	202.	6.62	967.97	222.36	111.18	180.18
380.00	200.	7.01	958.37	219.35	109.67	178.67
400.00	199.	7.41	953.56	217.44	108.72	177.72
420.00	198.	7.81	951.16	216.09	108.05	177.05
440.00	197.	8.21	946.36	214.20	107.10	176.10
460.00	197.	8.61	946.36	213.40	106.70	175.70
500.00	197.	9.43	943.95	211.27	105.63	174.63
540.00	197.	10.27	946.36	210.20	105.10	174.10
580.00	198.	11.11	951.16	209.66	104.83	173.83

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE C-202-B ,TESTED ON 23/04/1984 @ 10:00 AM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 2 PARTS CALCIUM CARBONATE + 8 PARTS WATER **
CONFINING PRESSURE = 69 KPA DRY DENSITY = 17.19 KN/M**3
WATER CONTENT AT TESTING=7.592% CURE PERIOD=14 DAYS IN WAX
SAMPLE LENGTH= 14.74 CM SAMPLE AREA= 41.36 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	69.00
5.00	77.0	0.09	369.90	89.36	44.68	113.68
10.00	114.0	0.17	547.64	132.19	66.10	135.09
15.00	141.0	0.26	677.34	163.36	81.68	150.68
20.00	159.0	0.35	763.81	184.05	92.03	161.03
25.00	174.0	0.43	835.87	201.24	100.62	169.62
30.00	185.0	0.52	888.71	213.78	106.89	175.89
35.00	192.5	0.61	924.74	222.25	111.13	180.13
40.00	198.5	0.69	953.56	228.98	114.49	183.49
45.00	203.0	0.78	975.18	233.97	116.98	185.98
50.00	206.5	0.87	991.99	237.80	118.90	187.90
55.00	209.0	0.96	1004.00	240.47	120.23	189.23
60.00	211.0	1.04	1013.61	242.56	121.28	190.28
70.00	214.5	1.22	1030.42	246.15	123.08	192.08
80.00	216.5	1.40	1040.03	248.01	124.01	193.01
90.00	217.5	1.58	1044.83	248.72	124.36	193.36
100.00	218.5	1.75	1049.64	249.43	124.71	193.71
110.00	219.0	1.93	1052.04	249.56	124.78	193.78
120.00	219.0	2.11	1052.04	249.12	124.56	193.56
130.00	219.0	2.29	1052.04	248.68	124.34	193.34
140.00	219.0	2.47	1052.04	248.25	124.12	193.12
150.00	218.5	2.65	1049.64	247.24	123.62	192.62
160.00	218.5	2.84	1049.64	246.80	123.40	192.40
170.00	218.0	3.02	1047.24	245.80	122.90	191.90
180.00	217.5	3.20	1044.83	244.80	122.40	191.40
190.00	216.5	3.38	1040.03	243.25	121.62	190.62
200.00	216.0	3.57	1037.63	242.25	121.13	190.13
210.00	215.0	3.75	1032.83	240.70	120.35	189.35
220.00	214.5	3.94	1030.42	239.71	119.86	188.86
230.00	213.5	4.13	1025.62	238.17	119.08	188.08
240.00	213.0	4.31	1023.22	237.18	118.59	187.59
250.00	212.5	4.50	1020.82	236.20	118.10	187.10
260.00	212.0	4.69	1018.41	235.22	117.61	186.61
270.00	211.5	4.88	1016.01	234.24	117.12	186.12
280.00	211.0	5.07	1013.61	233.27	116.63	185.63
290.00	210.5	5.26	1011.21	232.29	116.15	185.15
300.00	210.0	5.45	1008.81	231.32	115.66	184.66
310.00	209.0	5.64	1004.00	229.80	114.90	183.90
320.00	208.5	5.84	1001.60	228.83	114.42	183.42
340.00	208.0	6.22	999.20	227.45	113.73	182.73
360.00	206.5	6.61	991.99	224.98	112.49	181.49
380.00	206.0	7.01	989.59	223.61	111.81	180.81
400.00	205.5	7.40	987.19	222.25	111.12	180.12
420.00	205.0	7.80	984.79	220.89	110.44	179.44
440.00	205.0	8.20	984.79	220.07	110.03	179.03
460.00	205.0	8.61	984.79	219.25	109.62	178.62
480.00	205.0	9.02	984.79	218.43	109.21	178.21
500.00	205.5	9.43	987.19	218.14	109.07	178.07
520.00	206.5	9.84	991.99	218.37	109.19	178.19

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE C-301-A ,TESTED ON 18/04/1984 @ 3:30 PM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 3 PARTS CALCIUM CARBONATE + 8 PARTS WATER **

CONFINING PRESSURE = 69 KPA   DRY DENSITY = 17.41 KN/M**3
WATER CONTENT AT TESTING=7.83%   CURE PERIOD= 7 DAYS IN WAX
SAMPLE LENGTH= 14.72 CM   SAMPLE AREA= 41.22 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	69.00
5.00	71.0	0.09	341.07	82.68	41.34	110.34
10.00	108.0	0.17	518.81	125.66	62.83	131.83
15.00	131.0	0.26	629.30	152.29	76.15	145.15
20.00	152.0	0.35	730.18	176.55	88.28	157.28
25.00	168.0	0.43	807.04	194.97	97.48	166.48
30.00	180.0	0.52	864.69	208.71	104.36	173.36
35.00	189.0	0.61	907.93	218.96	109.48	178.48
40.00	195.0	0.69	936.75	225.71	112.86	181.86
45.00	200.0	0.78	960.77	231.30	115.65	184.65
50.00	203.5	0.87	977.58	235.14	117.57	186.57
55.00	206.0	0.96	989.59	237.82	118.91	187.91
60.00	208.5	1.05	1001.60	240.50	120.25	189.25
70.00	211.5	1.22	1016.01	243.54	121.77	190.77
80.00	214.0	1.40	1028.02	245.98	122.99	191.99
90.00	215.0	1.58	1032.83	246.70	123.35	192.35
100.00	216.0	1.76	1037.63	247.42	123.71	192.71
110.00	217.0	1.93	1042.43	248.12	124.06	193.06
120.00	217.0	2.11	1042.43	247.69	123.84	192.84
130.00	217.0	2.29	1042.43	247.25	123.63	192.63
140.00	217.0	2.47	1042.43	246.82	123.41	192.41
150.00	217.0	2.66	1042.43	246.38	123.19	192.19
160.00	217.0	2.84	1042.43	245.94	122.97	191.97
170.00	216.5	3.02	1040.03	244.94	122.47	191.47
180.00	216.0	3.20	1037.63	243.94	121.97	190.97
190.00	215.0	3.39	1032.83	242.38	121.19	190.19
200.00	214.5	3.57	1030.42	241.38	120.69	189.69
210.00	214.0	3.76	1028.02	240.39	120.20	189.20
220.00	213.0	3.94	1023.22	238.84	119.42	188.42
230.00	212.5	4.13	1020.82	237.85	118.93	187.93
240.00	212.0	4.32	1018.41	236.87	118.43	187.43
250.00	211.0	4.51	1013.61	235.32	117.66	186.66
260.00	210.0	4.70	1008.81	233.79	116.89	185.89
270.00	209.0	4.88	1004.00	232.25	116.13	185.13
280.00	208.0	5.08	999.20	230.72	115.36	184.36
290.00	207.0	5.27	994.39	229.20	114.60	183.60
300.00	206.0	5.46	989.59	227.68	113.84	182.84
310.00	205.0	5.65	984.79	226.16	113.08	182.08
320.00	204.0	5.84	979.98	224.65	112.32	181.32
340.00	203.0	6.23	975.18	222.73	111.36	180.36
360.00	201.0	6.62	965.57	219.73	109.86	178.86
380.00	199.5	7.01	958.37	217.28	108.64	177.64
400.00	198.5	7.41	953.56	215.40	107.70	176.70
420.00	198.0	7.81	951.16	214.06	107.03	176.03
440.00	198.0	8.21	951.16	213.26	106.63	175.63
480.00	197.5	9.03	948.76	211.14	105.57	174.57
520.00	198.0	9.85	951.16	210.08	105.04	174.04
560.00	199.5	10.69	958.37	210.06	105.03	174.03
600.00	201.0	11.54	965.57	210.03	105.01	174.01
620.00	202.0	11.98	970.38	210.26	105.13	174.13
640.00	203.0	12.41	975.18	210.48	105.24	174.24

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE C-206-A ,TESTED ON 03/06/1984 @ 10:30 AM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 2 PARTS CALCIUM CARBONATE + 8 PARTS WATER **
CONFINING PRESSURE = 69 KPA DRY DENSITY = 17.23 KN/M**3
WATER CONTENT AT TESTING=3.863% CURE PERIOD= 3 DAYS IN & OUT OF WAX
SAMPLE LENGTH= 14.71 CM SAMPLE AREA= 41.25 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	69.00
5.00	90.0	0.09	432.35	104.72	52.36	121.36
10.00	133.0	0.17	638.91	154.61	77.31	146.31
15.00	164.0	0.26	787.83	190.49	95.24	164.24
20.00	184.0	0.35	883.91	213.53	106.77	175.77
25.00	206.0	0.43	989.59	238.86	119.43	188.43
30.00	224.0	0.52	1076.06	259.50	129.75	198.75
35.00	233.0	0.61	1119.29	269.69	134.85	203.85
40.00	243.0	0.70	1167.33	281.03	140.51	209.51
45.00	249.0	0.78	1196.16	287.71	143.86	212.86
50.00	253.0	0.87	1215.37	292.08	146.04	215.04
55.00	254.0	0.96	1220.17	292.98	146.49	215.49
60.00	255.0	1.05	1224.98	293.88	146.94	215.94
70.00	255.0	1.22	1224.98	293.37	146.68	215.68
80.00	254.0	1.40	1220.17	291.70	145.85	214.85
90.00	253.0	1.58	1215.37	290.05	145.02	214.02
100.00	252.0	1.76	1210.57	288.39	144.20	213.20
110.00	251.0	1.94	1205.76	286.75	143.37	212.37
120.00	250.0	2.12	1200.96	285.10	142.55	211.55
130.00	247.0	2.30	1186.55	281.18	140.59	209.59
140.00	245.0	2.48	1176.94	278.41	139.21	208.21
150.00	242.0	2.66	1162.53	274.52	137.26	206.26
160.00	239.0	2.84	1148.12	270.63	135.32	204.32
170.00	236.0	3.02	1133.71	266.76	133.38	202.38
180.00	233.0	3.21	1119.29	262.90	131.45	200.45
190.00	232.0	3.39	1114.49	261.31	130.65	199.65
200.00	231.0	3.58	1109.69	259.72	129.86	198.86
210.00	230.0	3.76	1104.88	258.13	129.07	198.07
220.00	229.0	3.95	1100.08	256.55	128.27	197.27
230.00	228.0	4.13	1095.28	254.97	127.48	196.48
240.00	227.0	4.32	1090.47	253.39	126.70	195.70
250.00	226.0	4.51	1085.67	251.82	125.91	194.91
260.00	225.0	4.70	1080.86	250.26	125.13	194.13
270.00	224.0	4.89	1076.06	248.70	124.35	193.35
280.00	223.0	5.08	1071.26	247.14	123.57	192.57
290.00	222.0	5.27	1066.45	245.58	122.79	191.79
300.00	222.0	5.46	1066.45	245.14	122.57	191.57
310.00	222.0	5.65	1066.45	244.69	122.34	191.34

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE C-206-B ,TESTED ON 03/06/1984 @ 11:30 AM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 2 PARTS CALCIUM CARBONATE + 8 PARTS WATER **

CONFINING PRESSURE = 69 KPA   DRY DENSITY = 17.20 KN/M**3
WATER CONTENT AT TESTING=3.802%   CURE PERIOD= 3 DAYS IN & OUT OF WAX
SAMPLE LENGTH= 14.72 CM   SAMPLE AREA= 41.30 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	69.00
5.00	80.0	0.09	384.31	92.97	46.48	115.48
10.00	123.0	0.17	590.87	142.81	71.41	140.41
15.00	154.0	0.26	739.79	178.65	89.32	158.32
20.00	174.0	0.35	835.87	201.68	100.84	169.84
25.00	197.0	0.43	946.36	228.14	114.07	183.07
30.00	214.0	0.52	1028.02	247.61	123.80	192.80
35.00	223.0	0.61	1071.26	257.80	128.90	197.90
40.00	233.0	0.69	1119.29	269.13	134.56	203.56
45.00	239.0	0.78	1148.12	275.82	137.91	206.91
50.00	243.0	0.87	1167.33	280.19	140.09	209.09
55.00	245.0	0.96	1176.94	282.25	141.12	210.12
60.00	247.0	1.05	1186.55	284.30	142.15	211.15
70.00	249.0	1.22	1196.16	286.11	143.05	212.05
80.00	250.0	1.40	1200.96	286.75	143.38	212.38
90.00	248.0	1.58	1191.35	283.96	141.98	210.98
100.00	246.0	1.76	1181.74	281.18	140.59	209.59
110.00	245.0	1.93	1176.94	279.54	139.77	208.77
120.00	244.0	2.11	1172.14	277.91	138.96	207.96
130.00	243.0	2.29	1167.33	276.29	138.14	207.14
140.00	241.0	2.47	1157.72	273.53	136.76	205.76
150.00	240.0	2.66	1152.92	271.91	135.96	204.96
160.00	239.0	2.84	1148.12	270.30	135.15	204.15
170.00	238.0	3.02	1143.31	268.69	134.35	203.35
180.00	237.0	3.20	1138.51	267.09	133.54	202.54
190.00	235.5	3.39	1131.30	264.93	132.46	201.46
200.00	234.0	3.57	1124.10	262.77	131.38	200.38
210.00	233.0	3.76	1119.29	261.18	130.59	199.59
220.00	232.0	3.94	1114.49	259.59	129.80	198.80
230.00	231.0	4.13	1109.69	258.01	129.00	198.00
240.00	230.0	4.32	1104.88	256.43	128.22	197.22
250.00	228.5	4.51	1097.68	254.30	127.15	196.15
260.00	228.0	4.70	1095.28	253.29	126.64	195.64
270.00	227.5	4.89	1092.87	252.27	126.14	195.14
280.00	227.0	5.08	1090.47	251.26	125.63	194.63
290.00	227.0	5.27	1090.47	250.81	125.40	194.40
300.00	227.0	5.46	1090.47	250.35	125.18	194.18
310.00	227.0	5.65	1090.47	249.90	124.95	193.95
320.00	227.0	5.84	1090.47	249.44	124.72	193.72
340.00	228.0	6.23	1095.28	249.63	124.81	193.81

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE C-205-A ,TESTED ON 29/05/1984 @ 5:30 PM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 2 PARTS CALCIUM CARBONATE + 8 PARTS WATER **
CONFINING PRESSURE = 69 KPA   DRY DENSITY = 17.18 KN/M**3
WATER CONTENT AT TESTING=0.507%   CURE PERIOD= 7 DAYS IN & OUT OF WAX
SAMPLE LENGTH= 14.71 CM   SAMPLE AREA= 41.23 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	69.00
5.00	102.0	0.09	489.99	118.75	59.38	128.38
10.00	247.0	0.17	1186.55	287.31	143.66	212.66
15.00	352.0	0.26	1690.95	409.10	204.55	273.55
20.00	415.0	0.35	1993.59	481.89	240.95	309.95
25.00	446.0	0.44	2142.51	517.44	258.72	327.72
30.00	463.0	0.52	2224.18	536.70	268.35	337.35
35.00	472.0	0.61	2267.41	546.65	273.33	342.33
40.00	475.0	0.70	2281.82	549.64	274.82	343.82
45.00	475.0	0.79	2281.82	549.16	274.58	343.58
50.00	472.5	0.88	2269.81	545.80	272.90	341.90
55.00	468.5	0.96	2250.60	540.70	270.35	339.35
60.00	463.5	1.05	2226.58	534.46	267.23	336.23
70.00	451.0	1.23	2166.53	519.14	259.57	328.57
80.00	434.0	1.41	2084.87	498.69	249.35	318.35
90.00	402.0	1.59	1931.14	461.11	230.55	299.55
100.00	350.0	1.77	1681.34	400.76	200.38	269.38
110.00	294.0	1.95	1412.33	336.04	168.02	237.02
120.00	248.0	2.13	1191.35	282.96	141.48	210.48
130.00	230.0	2.31	1104.88	261.96	130.98	199.98
140.00	230.0	2.49	1104.88	261.49	130.75	199.75
150.00	231.0	2.67	1109.69	262.16	131.08	200.08

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE C-205-B ,TESTED ON 29/05/1984 @ 6:30 PM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 2 PARTS CALCIUM CARBONATE + 8 PARTS WATER **
CONFINING PRESSURE = 69 KPA DRY DENSITY = 17.37 KN/M**3
WATER CONTENT AT TESTING=0.495% CURE PERIOD= 7 DAYS IN & OUT OF WAX
SAMPLE LENGTH= 14.73 CM SAMPLE AREA= 41.06 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	69.00
5.00	98.0	0.09	470.78	114.57	57.28	126.28
10.00	225.0	0.17	1080.86	262.81	131.41	200.41
15.00	333.0	0.26	1599.68	388.62	194.31	263.31
20.00	396.0	0.35	1902.32	461.75	230.87	299.87
25.00	436.0	0.43	2094.47	507.95	253.98	322.98
30.00	457.0	0.52	2195.35	531.95	265.98	334.98
35.00	469.0	0.61	2253.00	545.45	272.72	341.72
40.00	475.5	0.69	2284.22	552.53	276.26	345.26
50.00	477.5	0.87	2293.83	553.89	276.94	345.94
55.00	474.5	0.96	2279.42	549.93	274.97	343.97
60.00	470.5	1.05	2260.21	544.82	272.41	341.41
70.00	461.0	1.22	2214.57	532.89	266.44	335.44
80.00	448.0	1.40	2152.12	516.96	258.48	327.48
90.00	432.0	1.58	2075.26	497.62	248.81	317.81
100.00	400.0	1.76	1921.53	459.95	229.98	298.98
110.00	370.0	1.93	1777.42	424.71	212.36	281.36
120.00	332.0	2.11	1594.87	380.42	190.21	259.21
130.00	296.0	2.29	1421.94	338.57	169.29	238.29
140.00	268.0	2.47	1287.43	306.01	153.00	222.00
150.00	257.0	2.66	1234.59	292.93	146.46	215.46
160.00	254.0	2.84	1220.17	289.00	144.50	213.50
170.00	255.0	3.02	1224.98	289.62	144.81	213.81
180.00	256.0	3.20	1229.78	290.24	145.12	214.12
190.00	257.0	3.39	1234.59	290.85	145.43	214.43

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE C-204-A ,TESTED ON 05/06/1984 @ 11:30 AM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 2 PARTS CALCIUM CARBONATE + 8 PARTS WATER **
CONFINING PRESSURE = 69 KPA   DRY DENSITY = 17.25 KN/M**3
WATER CONTENT AT TESTING=0.443%   CURE PERIOD=14 DAYS IN & OUT OF WAX
SAMPLE LENGTH= 14.70 CM   SAMPLE AREA= 41.42 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	69.00
5.00	135.0	0.09	648.52	156.43	78.22	147.22
10.00	300.0	0.17	1441.15	347.33	173.67	242.66
15.00	412.0	0.26	1979.18	476.59	238.29	307.29
20.00	470.0	0.35	2257.80	543.21	271.60	340.60
25.00	494.0	0.43	2373.10	570.45	285.23	354.23
30.00	505.5	0.52	2428.34	583.23	291.61	360.61
35.00	510.0	0.61	2449.96	587.91	293.95	362.95
40.00	511.0	0.70	2454.76	588.55	294.27	363.27
45.00	509.0	0.78	2445.15	585.73	292.87	361.87
50.00	504.5	0.87	2423.54	580.05	290.02	359.02
55.00	498.5	0.96	2394.71	572.65	286.33	355.33
60.00	492.0	1.05	2363.49	564.69	282.35	351.35
70.00	477.0	1.22	2291.43	546.52	273.26	342.26
80.00	458.0	1.40	2200.16	523.83	261.92	330.92
90.00	432.0	1.58	2075.26	493.23	246.61	315.61
100.00	387.0	1.76	1859.09	441.08	220.54	289.54
110.00	343.0	1.94	1647.72	390.24	195.12	264.12
120.00	305.0	2.12	1465.17	346.40	173.20	242.20
130.00	289.0	2.30	1388.31	327.64	163.82	232.82
140.00	283.5	2.48	1361.89	320.84	160.42	229.42
150.00	283.5	2.66	1361.89	320.27	160.14	229.14
160.00	277.0	2.84	1330.66	312.37	156.19	225.19
170.00	267.0	3.03	1282.62	300.56	150.28	219.28
180.00	263.5	3.21	1265.81	296.09	148.05	217.05
190.00	263.5	3.39	1265.81	295.57	147.78	216.78
200.00	263.5	3.58	1265.81	295.04	147.52	216.52
210.00	264.0	3.77	1268.21	295.07	147.53	216.53
220.00	264.0	3.95	1268.21	294.54	147.27	216.27

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE C-204-B ,TESTED ON 05/06/1984 @ 1:00 PM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 2 PARTS CALCIUM CARBONATE + 8 PARTS WATER **
CONFINING PRESSURE = 69 KPA DRY DENSITY = 17.25 KN/M**3
WATER CONTENT AT TESTING=0.438% CURE PERIOD=14 DAYS IN & OUT OF WAX
SAMPLE LENGTH= 14.71 CM SAMPLE AREA= 41.48 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	69.00
5.00	106.0	0.09	509.21	122.65	61.33	130.32
10.00	240.0	0.17	1152.92	277.46	138.73	207.73
15.00	365.0	0.26	1753.40	421.60	210.80	279.80
20.00	440.0	0.35	2113.69	507.79	253.90	322.90
25.00	482.0	0.43	2315.45	555.78	277.89	346.89
30.00	504.0	0.52	2421.13	580.65	290.32	359.32
35.00	514.0	0.61	2469.17	591.65	295.83	364.83
40.00	518.0	0.70	2488.39	595.74	297.87	366.87
45.00	518.5	0.78	2490.79	595.80	297.90	366.90
50.00	516.5	0.87	2481.18	592.98	296.49	365.49
55.00	512.0	0.96	2459.57	587.30	293.65	362.65
60.00	506.0	1.05	2430.74	579.92	289.96	358.96
70.00	487.0	1.22	2339.47	557.17	278.58	347.58
80.00	455.0	1.40	2185.75	519.65	259.82	328.82
90.00	406.0	1.58	1950.36	462.87	231.44	300.44
110.00	230.0	1.94	1104.88	261.30	130.65	199.65
120.00	230.0	2.12	1104.88	260.84	130.42	199.42
130.00	230.0	2.30	1104.88	260.38	130.19	199.19
140.00	230.0	2.48	1104.88	259.92	129.96	198.96
150.00	231.0	2.66	1109.69	260.59	130.29	199.29

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE C-203-A ,TESTED ON 29/05/1984 @ 7:30 PM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 2 PARTS CALCIUM CARBONATE + 8 PARTS WATER **
CONFINING PRESSURE = 69 KPA DRY DENSITY = 17.25 KN/M**3
WATER CONTENT AT TESTING=0.446% CURE PERIOD=28 DAYS IN & OUT OF WAX
SAMPLE LENGTH= 14.69 CM SAMPLE AREA= 41.37 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	69.00
5.00	103.0	0.09	494.80	119.49	59.75	128.75
10.00	213.0	0.17	1023.22	246.90	123.45	192.45
15.00	319.0	0.26	1532.42	369.45	184.72	253.72
20.00	404.0	0.35	1940.75	467.48	233.74	302.74
25.00	453.0	0.43	2176.14	523.73	261.86	330.86
30.00	479.0	0.52	2301.04	553.30	276.65	345.65
35.00	492.0	0.61	2363.49	567.83	283.91	352.91
40.00	498.0	0.70	2392.31	574.25	287.13	356.13
45.00	499.0	0.78	2397.12	574.91	287.45	356.45
50.00	498.0	0.87	2392.31	573.25	286.63	355.63
55.00	494.5	0.96	2375.50	568.73	284.36	353.36
60.00	490.0	1.05	2353.88	563.06	281.53	350.53
70.00	478.0	1.22	2296.23	548.31	274.16	343.16
80.00	465.5	1.40	2236.19	533.04	266.52	335.52
90.00	448.0	1.58	2152.12	512.10	256.05	325.05
100.00	412.0	1.76	1979.18	470.12	235.06	304.06
110.00	330.0	1.94	1585.27	375.89	187.95	256.95
120.00	266.0	2.12	1277.82	302.46	151.23	220.23
130.00	260.0	2.30	1249.00	295.11	147.56	216.56
140.00	256.0	2.48	1229.78	290.06	145.03	214.03
150.00	253.0	2.66	1215.37	286.15	143.08	212.08
160.00	250.0	2.84	1200.96	282.26	141.13	210.13
170.00	248.5	3.03	1193.75	280.07	140.03	209.03
180.00	248.5	3.21	1193.75	279.57	139.78	208.78

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE C-203-B ,TESTED ON 29/05/1984 @ 8:30 PM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 2 PARTS CALCIUM CARBONATE + 8 PARTS WATER **
CONFINING PRESSURE = 69 KPA DRY DENSITY = 17.32 KN/M**3
WATER CONTENT AT TESTING=0.444% CURE PERIOD=28 DAYS IN & OUT OF WAX
SAMPLE LENGTH= 14.68 CM SAMPLE AREA= 40.77 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	69.00
5.00	102.0	0.09	489.99	120.07	60.03	129.03
10.00	273.0	0.17	1311.45	321.08	160.54	229.54
15.00	385.0	0.26	1849.48	452.41	226.21	295.21
20.00	444.0	0.35	2132.90	521.29	260.65	329.65
30.00	482.0	0.52	2315.45	564.93	282.46	351.46
35.00	490.5	0.61	2356.28	574.39	287.19	356.19
40.00	494.0	0.70	2373.10	577.98	288.99	357.99
45.00	494.5	0.78	2375.50	578.06	289.03	358.03
50.00	493.0	0.87	2368.29	575.81	287.90	356.90
55.00	490.0	0.96	2353.88	571.81	285.90	354.90
60.00	485.0	1.05	2329.86	565.48	282.74	351.74
70.00	474.0	1.23	2277.02	551.69	275.84	344.84
80.00	463.0	1.40	2224.18	537.94	268.97	337.97
90.00	451.0	1.58	2166.53	523.08	261.54	330.54
100.00	436.5	1.76	2096.88	505.37	252.69	321.68
110.00	400.0	1.94	1921.53	462.30	231.15	300.15
120.00	330.0	2.12	1585.27	380.72	190.36	259.36
130.00	278.0	2.30	1335.47	320.16	160.08	229.08
140.00	262.0	2.48	1258.61	301.20	150.60	219.60
150.00	255.0	2.66	1224.98	292.63	146.32	215.32
160.00	253.5	2.85	1217.77	290.40	145.20	214.20
170.00	254.5	3.03	1222.58	291.02	145.51	214.51
180.00	254.5	3.21	1222.58	290.50	145.25	214.25
190.00	253.0	3.40	1215.37	288.28	144.14	213.14
200.00	250.0	3.58	1200.96	284.35	142.17	211.17
210.00	249.0	3.77	1196.16	282.70	141.35	210.35
220.00	249.0	3.96	1196.16	282.20	141.10	210.10

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE C-303-A ,TESTED ON 07/06/1984 @ 1:00 PM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 3 PARTS CALCIUM CARBONATE + 8 PARTS WATER **
CONFINING PRESSURE = 69 KPA DRY DENSITY = 17.42 KN/M**3
WATER CONTENT AT TESTING=0.446% CURE PERIOD= 7 DAYS IN & OUT OF WAX
SAMPLE LENGTH= 14.70 CM SAMPLE AREA= 41.53 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	69.00
5.00	101.0	0.09	485.19	116.72	58.36	127.36
10.00	260.0	0.17	1249.00	300.22	150.11	219.11
15.00	382.0	0.26	1835.07	440.71	220.36	289.36
20.00	450.0	0.35	2161.73	518.71	259.36	328.36
25.00	487.0	0.43	2339.47	560.88	280.44	349.44
30.00	507.0	0.52	2435.55	583.40	291.70	360.70
35.00	517.5	0.61	2485.99	594.97	297.48	366.48
40.00	522.0	0.70	2507.60	599.62	299.81	368.81
45.00	522.5	0.78	2510.01	599.67	299.84	368.84
50.00	520.0	0.87	2498.00	596.28	298.14	367.14
55.00	516.5	0.96	2481.18	591.75	295.88	364.88
60.00	511.5	1.05	2457.16	585.52	292.76	361.76
70.00	500.5	1.22	2404.32	571.92	285.96	354.96
80.00	487.0	1.40	2339.47	555.52	277.76	346.76
90.00	473.0	1.58	2272.22	538.61	269.30	338.30
100.00	453.0	1.76	2176.14	514.93	257.46	326.46
110.00	390.0	1.94	1873.50	442.54	221.27	290.27
120.00	300.0	2.12	1441.15	339.81	169.91	238.91
130.00	244.0	2.30	1172.14	275.89	137.95	206.95
140.00	244.0	2.48	1172.14	275.41	137.70	206.70
150.00	244.0	2.66	1172.14	274.92	137.46	206.46

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE C-303-B ,TESTED ON 07/06/1984 @ 1:30 PM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 3 PARTS CALCIUM CARBONATE + 8 PARTS WATER **
CONFINING PRESSURE = 69 KPA DRY DENSITY = 17.39 KN/M**3
WATER CONTENT AT TESTING=0.453% CURE PERIOD= 7 DAYS IN & OUT OF WAX
SAMPLE LENGTH= 14.69 CM SAMPLE AREA= 41.64 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	69.00
5.00	95.0	0.09	456.36	109.50	54.75	123.75
10.00	244.0	0.17	1172.14	281.00	140.50	209.50
15.00	375.0	0.26	1801.44	431.49	215.74	284.74
20.00	443.0	0.35	2128.10	509.29	254.64	323.64
25.00	479.0	0.43	2301.04	550.20	275.10	344.10
30.00	498.0	0.52	2392.31	571.53	285.76	354.76
35.00	508.0	0.61	2440.35	582.50	291.25	360.25
40.00	512.0	0.70	2459.57	586.57	293.29	362.29
45.00	512.5	0.78	2461.97	586.63	293.32	362.32
50.00	510.5	0.87	2452.36	583.84	291.92	360.92
55.00	507.0	0.96	2435.55	579.33	289.66	358.66
60.00	502.0	1.05	2411.53	573.11	286.56	355.56
70.00	490.0	1.22	2353.88	558.44	279.22	348.22
80.00	476.0	1.40	2286.63	541.53	270.77	339.77
90.00	455.0	1.58	2185.75	516.73	258.37	327.37
100.00	416.0	1.76	1998.40	471.61	235.81	304.81
110.00	374.0	1.94	1796.64	423.25	211.63	280.63
120.00	339.0	2.12	1628.50	382.97	191.48	260.48
130.00	318.0	2.30	1527.62	358.61	179.30	248.30
140.00	306.0	2.48	1469.97	344.47	172.23	241.23
150.00	298.0	2.66	1431.54	334.87	167.43	236.43
160.00	294.0	2.84	1412.33	329.79	164.89	233.89
170.00	288.0	3.03	1383.50	322.48	161.24	230.24
180.00	283.0	3.21	1359.49	316.32	158.16	227.16
190.00	273.0	3.40	1311.45	304.60	152.30	221.30
200.00	261.5	3.58	1256.20	291.24	145.62	214.62
210.00	255.0	3.77	1224.98	283.50	141.75	210.75
220.00	252.0	3.95	1210.57	279.66	139.83	208.83
230.00	251.0	4.14	1205.76	278.05	139.02	208.02
240.00	250.5	4.33	1203.36	276.99	138.50	207.50
250.00	250.0	4.52	1200.96	275.94	137.97	206.97
260.00	251.0	4.71	1205.76	276.55	138.27	207.27

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE C-302-A ,TESTED ON 16/05/1984 @ 7:30 AM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 3 PARTS CALCIUM CARBONATE + 8 PARTS WATER **
CONFINING PRESSURE = 69 KPA DRY DENSITY = 17.38 KN/M**3
WATER CONTENT AT TESTING=0.809% CURE PERIOD=14 DAYS IN & OUT OF WAX
SAMPLE LENGTH= 14.71 CM SAMPLE AREA= 41.34 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	69.00
5.00	70.0	0.09	336.27	81.00	40.50	109.50
10.00	130.0	0.17	624.50	150.29	75.15	144.14
15.00	208.0	0.26	999.20	240.26	120.13	189.13
20.00	268.0	0.35	1287.43	309.29	154.65	223.65
25.00	318.0	0.43	1527.62	366.68	183.34	252.34
30.00	355.0	0.52	1705.36	408.99	204.49	273.49
35.00	386.0	0.61	1854.28	444.32	222.16	291.16
40.00	400.0	0.70	1921.53	460.03	230.02	299.01
45.00	412.0	0.78	1979.18	473.42	236.71	305.71
50.00	420.0	0.87	2017.61	482.19	241.10	310.10
55.00	425.0	0.96	2041.63	487.51	243.75	312.75
60.00	427.0	1.05	2051.24	489.37	244.69	313.69
70.00	429.0	1.22	2060.85	490.81	245.40	314.40
80.00	426.5	1.40	2048.84	487.09	243.55	312.55
90.00	421.0	1.58	2022.42	479.97	239.99	308.99
100.00	414.0	1.76	1988.79	471.16	235.58	304.58
110.00	406.0	1.94	1950.36	461.25	230.62	299.62
120.00	396.0	2.12	1902.32	449.09	224.55	293.55
130.00	381.0	2.30	1830.26	431.32	215.66	284.66
140.00	361.5	2.48	1736.59	408.52	204.26	273.26
150.00	343.0	2.66	1647.72	386.93	193.46	262.46
160.00	316.0	2.84	1518.01	355.84	177.92	246.92
170.00	295.0	3.02	1417.13	331.60	165.80	234.80
180.00	283.5	3.21	1361.89	318.11	159.05	228.05
190.00	281.0	3.39	1349.88	314.74	157.37	226.37
200.00	280.5	3.58	1347.48	313.62	156.81	225.81
210.00	281.0	3.76	1349.88	313.62	156.81	225.81
220.00	281.0	3.95	1349.88	313.05	156.53	225.53
230.00	281.5	4.14	1352.28	313.05	156.52	225.52

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE C-302-B ,TESTED ON 16/05/1984 @ 8:00 AM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 3 PARTS CALCIUM CARBONATE + 8 PARTS WATER **

CONFINING PRESSURE = 69 KPA DRY DENSITY = 17.48 KN/M**3
WATER CONTENT AT TESTING=0.850% CURE PERIOD=14 DAYS IN & OUT OF WAX
SAMPLE LENGTH= 14.71 CM SAMPLE AREA= 41.17 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	69.00
5.00	70.0	0.09	336.27	81.60	40.80	109.80
10.00	130.0	0.17	624.50	151.41	75.70	144.70
15.00	214.0	0.26	1028.02	249.03	124.51	193.51
20.00	283.0	0.35	1359.49	329.03	164.52	233.52
25.00	340.0	0.43	1633.31	394.96	197.48	266.48
30.00	380.0	0.52	1825.46	441.05	220.52	289.52
35.00	404.0	0.61	1940.75	468.50	234.25	303.25
40.00	420.0	0.70	2017.61	486.63	243.31	312.31
45.00	429.0	0.78	2060.85	496.62	248.31	317.31
50.00	435.0	0.87	2089.67	503.13	251.57	320.56
55.00	438.0	0.96	2104.08	506.16	253.08	322.08
60.00	439.0	1.05	2108.89	506.87	253.44	322.44
70.00	438.0	1.22	2104.08	504.83	252.42	321.42
80.00	434.0	1.40	2084.87	499.35	249.67	318.67
90.00	428.0	1.58	2056.04	491.58	245.79	314.79
100.00	420.5	1.76	2020.01	482.12	241.06	310.06
110.00	410.0	1.94	1969.57	469.26	234.63	303.63
120.00	392.0	2.12	1883.10	447.87	223.93	292.93
130.00	340.0	2.30	1633.31	387.77	193.89	262.88
140.00	280.0	2.48	1345.07	318.78	159.39	228.39
150.00	242.0	2.66	1162.53	275.03	137.51	206.51
160.00	242.0	2.84	1162.53	274.54	137.27	206.27
170.00	243.0	3.02	1167.33	275.18	137.59	206.59

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE C-402-A ,TESTED ON 07/06/1984 @ 10:30 AM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 4 PARTS CALCIUM CARBONATE + 8 PARTS WATER **
CONFINING PRESSURE = 69 KPA DRY DENSITY = 17.59 KN/M**3
WATER CONTENT AT TESTING=0.445% CURE PERIOD= 7 DAYS IN & OUT OF WAX
SAMPLE LENGTH= 14.70 CM SAMPLE AREA= 40.87 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	69.00
5.00	95.0	0.09	456.36	111.55	55.78	124.78
10.00	235.0	0.17	1128.90	275.71	137.85	206.85
15.00	348.0	0.26	1671.74	407.93	203.96	272.96
20.00	425.0	0.35	2041.63	497.76	248.88	317.88
25.00	470.0	0.43	2257.80	549.99	274.99	343.99
30.00	496.0	0.52	2382.70	579.91	289.95	358.95
40.00	515.0	0.70	2473.98	601.08	300.54	369.54
45.00	516.5	0.78	2481.18	602.30	301.15	370.15
50.00	515.0	0.87	2473.98	600.03	300.01	369.01
55.00	511.5	0.96	2457.16	595.43	297.72	366.72
60.00	506.0	1.05	2430.74	588.52	294.26	363.26
70.00	495.0	1.22	2377.90	574.72	287.36	356.36
80.00	480.0	1.40	2305.84	556.33	278.16	347.16
90.00	461.0	1.58	2214.57	533.37	266.69	335.69
100.00	428.0	1.76	2056.04	494.32	247.16	316.16
110.00	386.0	1.94	1854.28	445.03	222.51	291.51
120.00	353.0	2.12	1695.75	406.27	203.13	272.13
130.00	318.0	2.30	1527.62	365.34	182.67	251.67
140.00	240.0	2.48	1152.92	275.24	137.62	206.62
150.00	240.0	2.66	1152.92	274.75	137.38	206.38

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE C-402-B ,TESTED ON 07/06/1984 @ 11:30 AM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 4 PARTS CALCIUM CARBONATE + 8 PARTS WATER **
CONFINING PRESSURE = 69 KPA　　DRY DENSITY = 17.66 KN/M**3
WATER CONTENT AT TESTING=0.491%　　CURE PERIOD= 7 DAYS IN & OUT OF WAX
SAMPLE LENGTH= 14.71 CM　　SAMPLE AREA= 41.26 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	69.00
5.00	90.0	0.09	432.35	104.70	52.35	121.35
10.00	228.0	0.17	1095.28	265.01	132.50	201.50
15.00	340.0	0.26	1633.31	394.84	197.42	266.42
20.00	412.0	0.35	1979.18	478.05	239.02	308.02
25.00	460.0	0.43	2209.77	533.28	266.64	335.64
30.00	488.0	0.52	2344.27	565.25	282.62	351.62
35.00	503.0	0.61	2416.33	582.12	291.06	360.06
40.00	510.0	0.70	2449.96	589.70	294.85	363.85
45.00	512.5	0.78	2461.97	592.08	296.04	365.04
50.00	512.5	0.87	2461.97	591.56	295.78	364.78
55.00	510.0	0.96	2449.96	588.17	294.08	363.08
60.00	507.0	1.05	2435.55	584.20	292.10	361.10
70.00	497.0	1.22	2387.51	571.68	285.84	354.84
80.00	483.0	1.40	2320.25	554.60	277.30	346.30
90.00	468.0	1.58	2248.20	536.44	268.22	337.22
100.00	445.0	1.76	2137.71	509.18	254.59	323.59
110.00	421.0	1.94	2022.42	480.87	240.44	309.44
120.00	398.0	2.12	1911.93	453.80	226.90	295.90
130.00	313.0	2.30	1503.60	356.25	178.13	247.13
140.00	280.0	2.48	1345.07	318.13	159.07	228.07
150.00	250.0	2.66	1200.96	283.54	141.77	210.77
160.00	250.0	2.84	1200.96	283.04	141.52	210.52
170.00	251.0	3.02	1205.76	283.67	141.83	210.83

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE C-401-A ,TESTED ON 13/06/1984 @ 3:00 PM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 4 PARTS CALCIUM CARBONATE + 8 PARTS WATER **
CONFINING PRESSURE = 69 KPA DRY DENSITY = 17.64 KN/M**3
WATER CONTENT AT TESTING=0.280% CURE PERIOD=14 DAYS IN & OUT OF WAX
SAMPLE LENGTH= 14.69 CM SAMPLE AREA= 41.41 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	69.00
5.00	174.0	0.09	835.87	201.67	100.83	169.83
10.00	370.0	0.17	1777.42	428.46	214.23	283.23
15.00	497.0	0.26	2387.51	575.03	287.51	356.51
20.00	548.0	0.35	2632.50	633.49	316.74	385.74
25.00	570.0	0.43	2738.19	658.35	329.17	398.17
30.00	580.0	0.52	2786.23	669.31	334.66	403.66
35.00	583.5	0.61	2803.04	672.77	336.38	405.38
40.00	584.0	0.70	2805.44	672.76	336.38	405.38
45.00	580.0	0.78	2786.23	667.57	333.78	402.78
55.00	567.0	0.96	2723.78	651.47	325.73	394.73
60.00	559.0	1.05	2685.35	641.72	320.86	389.86
70.00	538.0	1.23	2584.46	616.53	308.26	377.26
80.00	480.0	1.40	2305.84	549.10	274.55	343.55
90.00	370.0	1.58	1777.42	422.52	211.26	280.26
100.00	260.0	1.76	1249.00	296.39	148.19	217.19
110.00	250.0	1.94	1200.96	284.49	142.24	211.24
120.00	250.0	2.12	1200.96	283.98	141.99	210.99

** UNSATURATED UNDRAINED TRIAXIAL COMPRESSION TEST **

** SAMPLE C-401-B ,TESTED ON 13/06/1984 @ 4:00 PM **
** COMPOSITION OF MIX(BY WEIGHT)= 100 PARTS FINE SAND
+ 4 PARTS CALCIUM CARBONATE + 8 PARTS WATER **
CONFINING PRESSURE = 69 KPA   DRY DENSITY = 17.70 KN/M**3
WATER CONTENT AT TESTING=0.269%   CURE PERIOD=14 DAYS IN & OUT OF WAX
SAMPLE LENGTH= 14.70 CM   SAMPLE AREA= 40.98 CM**2

DDR DIV.	LDR DIV.	CS %	LOAD N	DS KPA	Q KPA	P KPA
0.00	0.0	0.00	0.00	0.00	0.00	69.00
5.00	178.0	0.09	655.08	208.49	104.24	173.24
10.00	375.0	0.17	1801.44	438.85	219.42	288.42
15.00	498.0	0.26	2392.31	582.28	291.14	360.14
20.00	554.0	0.35	2661.33	647.20	323.60	392.60
25.00	576.0	0.43	2767.01	672.32	336.16	405.16
30.00	585.0	0.52	2810.25	682.23	341.11	410.11
35.00	586.5	0.61	2817.45	683.38	341.69	410.69
40.00	585.0	0.70	2810.25	681.04	340.52	409.52
50.00	573.0	0.87	2752.60	665.91	332.96	401.96
55.00	564.5	0.96	2711.77	655.46	327.73	396.73
60.00	556.5	1.05	2673.34	645.61	322.81	391.81
70.00	537.0	1.22	2579.66	621.90	310.95	379.95
80.00	511.0	1.40	2454.76	590.76	295.38	364.38
90.00	470.0	1.58	2257.80	542.40	271.20	340.20
100.00	350.0	1.76	1681.34	403.21	201.60	270.60
110.00	250.0	1.94	1200.96	287.50	143.75	212.75
120.00	250.0	2.12	1200.96	286.99	143.50	212.50